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ARE RAILROADS PUBLIC ENEMIES?

By APPLETON MORGAN.

THE American Railroad, as an institution, is not immaculate. Its general offices are no more insured against entrance of designing and wickedly-minded men than is the pulpit, the Sunday-school, or the strawberry-festival. Granted, however, that, like most human concerns, the American railroad needs reformation, the very considerable question arises, Where shall we look for the reformer? It has not yet come, perhaps, to be a principle in economics that the safest and most expert administrator of a specialty is the one who has had the least practical experience thereof. But there nevertheless appears to be, if not an exact enunciation of such a principle, a by no means unusual tendency to such a practice. A great transatlantic steamship, *en route* from shore to shore, or a limited express train, with its costly freightage of packed Pullman, express, and baggage carriages, easily represents millions in money value, besides its human freightage. The captain, the conductor, the engineers, and crew are picked men, raised to their several responsibilities through every lower grade of drill and experience, adapted each to his part by long usuetude: who have been intrusted with all this precious burden by those who must answer with their fortunes, their liberty even, for the waste of its loss. Let the great steamship founder, the limited crash through a trestle—living or dead, these men will be found at their posts. But there will never fail of gifted gentlemen, eminent conversationalists, ready writers to the newspapers, who happened to be in their downy beds while these men were perishing, but who, nevertheless, will tell us exactly what this company and their picked employés should have done, and how the catastrophe might have been avoided. The design of this paper is to call attention to a recent capital instance of this tendency.

The problem of railway management and operation has grown so intricate; so vast, so complicated and enormous, that it is a maxim that no one man, whatever his habitude, knows "how to run a railroad." The executive officer, the auditor, superintendent or actuary of twenty-five years' service, instead of having kept abreast of his employment, finds that his service has outgrown him, not in fact alone, but in proportion; and that he can deal with remote details only when concreted by his subordinates into results which in turn are *his* details. He is himself only the pendulum of the clock-work, the governor of the engine; without his co-operatives and assistants he is powerless, although at the outset of his quarter-century he may have been equal to every item of his department.

Take a single trunk line connecting the city of New York with that Western focus to which, like Rome, all roads lead—Chicago. Every one of its army of eighty thousand employés knows his duty: his duty, often duplicated, perhaps, yet not duplicated, since every item of circumstance must daily and hourly vary it. From the president to the track-walker, no single individual could justify his employment for an instant, did he not, besides his routine, know precisely the single and only proper thing to do to save life and property in any contingency, foreseen or unforeseen; and, moreover, how in the performance not to swerve one atom below or above his exact prerogative. And if—in operation, the reciprocal duties of these eighty thousand must be exactly and incessantly performed in order that every passenger and every pound of freight shall reach its debarkation in safety—what single mind can grasp the relation of numberless such trunk-lines to the great public who trust their lives, persons, and property to them all? Add to this situation that this public, having largely invested their fortunes in these very transporting lines, are dependent for its incomes from their prosperity. Does not the great ramification strike us as one rather too enormous for any single recipe to meet, or to be guided by any one infallible and inexorable rule of constant and rigid procedure?

There is not a single criticism of railway management or outbreak of popular anti-railway feeling which has not its own perfectly well-known periodicity. As a rule, they lapse with time and disappear without exposition. But that all these criticisms and complaints should be carefully clipped, hoarded, pasted together, and sent out as a monograph signed by one name, is an occurrence so exceptional that its occasion might seem to warrant a replication to the array, once for all. Such an occasion seems the appearance of a handsome volume from an eminent press, which not only deals with the entire problem above suggested as a whole (the "Railways and the Republic," by James F. Hudson, New York, 1886), but impresses further as compiled by a gentleman who not only has never been engaged in the management of railways, operatively or financially, but has never dis-

covered, in all the immense delicacy of mechanism which moves 8,778,581,061 of people one mile, and billions of dollars' worth of treasure in every direction across and along a continent in a single year, and supports a property representing $7,676,399,054 of securities, a single point for his admiration or even for his approval.

Archimedes had the world for a load and natural science for a lever; but even Archimedes was obliged to sigh for a place whereon to plant his fulcrum. It appears to me that, in this laborious work of five hundred closely printed octavo pages, what Mr. Hudson lacks most of all is a standpoint. He has a load, he has a grievance for a lever, but, since he can not himself float in space, he makes no impression on what he claims to be the burden to be moved. Mr. Hudson's want of standpoint is prominent at his very outset in his very title-page. He calls his book "The Railways and the Republic," thus antagonizing his two terms. But the grouping is vicious, to begin with; since railroads, whether regarded as legal entities or as companies of individuals, are as much part and parcel of the republic as is Mr. Hudson himself. Starting upon this false major premise, Mr. Hudson proceeds in the first of his eleven chapters to give us the indictment, the remaining ten to be the counts of the particulars.

The title given to this indictment, "The Problem of Railway Domination," is again illicit. Where is the "domination" to be eliminated? Frankly admitting that the present writer believes that railways belong to the persons whose money has built or purchased them, and that their *quasi*-public character is justified and satisfied by their honest performance, by the best methods that applied science up to date has furnished, of the duties of public transportation, he proposes from this standpoint to examine: first, Mr. Hudson's indictment as a whole, passing thereafter—as far as the limits of a single paper will allow—to the particulars exhibited.

According to Mr. Hudson, the railways of the United States either "dominate" at present, or propose sooner or later to "dominate," the republic. How? By being "gigantic monopolists," says Mr. Hudson. And how do they become gigantic monopolists? By being gigantic corporations, controlled by men of altogether too enormous private fortunes. Now, we have always known that a railway was a corporation, and that some of our railways might fairly be called "gigantic." But there is not one of these "gigantic" corporations which is, in any sense of the term known to dictionaries at least, a monopoly. To be exactly all-fours with the lexicographers, the only railways in the Union which are monopolies are countable on the fingers of one hand, and must be as insignificant in extent, capitalization, importance of terminals and every other characteristic, as they are in number. Everybody knows that a shipper or traveler from New York to any point in the United States has an abundant choice of routes before him. Whether his objective be Buffalo, New Orleans,

or San Francisco, or any city or town large enough to make a dot on the map, or any one of the ten thousand points reachable from every one of these, there are certainly half a dozen lines of railway at his option; and if there are two points in the United States between which there is but one means of transportation, it is because the points themselves are of such exceedingly minor importance that a second means has entirely failed to be a temptation to local capitalists. I once happened upon a railroad on the top of the Alleghany Mountains, five miles in length, called the Wilcox and Burning-Well Railroad, running between a tannery and a saw-mill, which—as there was no other means of going from one to the other except by taking an axe and a compass and tempting the aboriginal forest—might, I think, be fairly called a monopoly, especially since the owner of the railroad was also the owner of both the terminal tannery and the terminal saw-mill. But the great majority of American railways are, just now, competitors rather than monopolists, and, if gigantic at all, are gigantic competitors. It is to be admitted, of course, that to construct, maintain, and operate a "gigantic" railway, gigantic corporations may not be unnecessary.

Now, railways "dominate," says Mr. Hudson, by being these gigantic corporations against which units have no chance. But just as capital is the storage of labor, so a corporation is the aggregate of units, and if units can combine to "dominate" other and uncombined units, why can not these other units combine to resist the domination? Mr. Hudson does not recognize such a question, suggests no device by which the unit unassisted by capital can equal in strength the unit when so assisted, nor any reason why the units incorporated for transportation purposes should not compete for the transportation business of the units not incorporated for transportation purposes. This word "competition," however, is no favorite of Mr. Hudson's. He immensely prefers "domination": and properly so, too, since in the employment of the latter word lie not only his premises, but the conclusions at which he assumes to arrive. The railways, concreted, "dominate" the republic (that is to say, all the United States except the railways), and therefore, since they "dominate" by doing the transportation business of those not in that business, the only safety is to reverse the situation, so that the units not incorporated for transportation purposes should hereafter dominate the units who are so incorporated. In other words: Let our railroads, by all means, be run by men who do not understand railroading, and let those who do understand the running of railroads step down and out at once.

But why should those individually concerned in railway management step down and out? Why, says Mr. Hudson, because several of them have accumulated enormous fortunes; fortunes fabulous, even when compared with all the other private fortunes in the world. But whence come these ten or a dozen (if so many) vast fortunes?

Why, says Mr. Hudson, with admirable circumferentiality, from the domination of railways. Clearly we must get this kernel out of Mr. Hudson's crop if we are to proceed with him any further: and to dispose of it may require a moment or two of our attention.

The greatest of powers, undoubtedly, is the human brain; and, so long as it is the instinct of man to scheme for his own aggrandizement, certainly the greatest brain will scheme to the greatest profit to himself. A dozen men in the United States have been able to amass, from management (or, if the word is preferred, manipulation) of the railway systems of the country, the largest single fortunes known to history: not in land, in interests in estimated wealth, but in actual comfortable, convertible cash, representing no manual labor of their own, no commensurate investment of capital, and no proportional benefit to the race. But, because Mr. Hudson is virtuous, are there to be no more cakes and ale? Because Mr. Gould is very rich, are there to be no more railway companies? Because these dozen fortunes are beyond any heretofore conceived relation of reward for personal industry, is the material by manipulation of which they have been accumulated, noxious, bad in itself, and dangerous to the common weal? These fortunes are, for our present purpose, the pure result of brain-labor, the rewards of pure thought. Let us leave out of the reckoning whether they are honest or dishonest fortunes; or, if Mr. Hudson prefers, let us concede them to be dishonest. The fact, the only fact, necessary to the discussion of his own questions on his own ground is that they have been accumulated by the purchase, manipulation, and operation of railways. The people make the laws, not the railroads. To argue that railroads, *quoad* railroads, are hateful to public policy, dangerous to the public peace, threatening to public morals, and destined in time to destroy the commonwealth, as private luxury once destroyed old Rome, seems to me the simple fallacy which logicians call an "undistributed middle." As well condemn any other thing because at some time something of its species has been manipulated to a personal and exorbitant profit. Banish corn, wheat, or coal, because great "corners" have been planned in those staples, and hundreds of thousands of consumers obliged to pay more than they ought to have paid, when a few schemers, who had schemed for months, had suddenly sprung upon these unsuspecting thousands their long-perfected plans!

Shakespeare makes one of his characters put the question, "How do men live?" and another answers it: "Marry, as the fishes in the sea, the big ones eat up the little ones." The struggle for existence which our brute ancestors carried on with teeth and claws and fangs, we still perpetuate with interlocked and grappling brains. They strove and tore and trampled each other for the food their bellies craved, *in specie;* we fight for values instead. But the result is the same: the strongest brain, as once the strongest limb, wins. And when, as within

the last half-century right here in the United States, in what is scarcely more than the close of the first half-century of the railroad, a few phenomenal brains have amassed more of these values than their share, more than they can consume with their own personal wants—while I admit that the problem looks serious to those whose brains have not taken part in the struggle—the wrong seems to me one for which Nature, not art or science or schools, is at present mostly responsible, just as much as she is responsible for the lion that rends the ox, or the fox that pillages the farm-yard. The United States of America does not make treaties with individuals: and yet the treaty between the United States and the kingdom of Hawaii is, or was once, practically for the single benefit of one man. Why? Because there happens to be but one article of export from Hawaii to the United States; and because that one product happens, or happened, to be controlled by the brains and capital of one man. So this anomaly—this wrong, we suppose Mr. Hudson would call it—is to be charged to the crime of having brains, or to the domination of (not railways this time, but) sugar! Perhaps the situation can be made very clear to Mr. Hudson by a quotation from himself:

He says, page 1: "Watt could see in the steam which lifted the lid from the tea-kettle a force which might yield man some aid in his labors; but he could not foresee the immense application of that force to every phase of life. He could not dream of the millions of factories, the thousands of steamships, or the myriads of railway-trains that lay dormant in his discovery." And yet it is simply and solely because a human brain here and there did foresee what Mr. Hudson says Watt could not or did not—that massive fortunes, larger than an aggregate of thousands amassed by mere manual labor and economy, have been accumulated. Shall the owner of such a brain assume that Nature in so endowing him endowed him with a curse to his fellow-men, and that it is his natural or moral duty to devise a means of redistributing this accumulation to the two hundred thousand or hundred thousand millions who, like Watt, could not foresee? I do not so understand Mr. Hudson to urge; but perhaps he will be able to demonstrate to what other duty his satire on the men who, by building, buying, controlling and operating railways, amass vast properties, surely and implacably points.

The processes by which the fish with capital swallows the fish without capital—by which money attracts money, and foresight eclipses hindsight—stand possibly in bolder and nearer relief, just now, in the case of the three or five railway kings (whose fortunes may last another generation or two without division) than elsewhere. But, that they are processes unfamiliar in any given commercial undertaking or venture, I do not find any note in Mr. Hudson's indictment to assert. His indictment of railways and railway management is the constant and simple and single charge that they "dominate" the non-railway world

by making the rich richer and the poor poorer; and this, principally, by piling up vast accumulations of wealth in the hands of the very few. Mr. Hudson is wary enough to see that railroads, not being *per se* illegal, the accident and consequence are not illegal; he, therefore, argues deftly that the railways, although legal, are illegally handled by their managers. This illegality he separates into five counts—that the transportation business, legitimate in itself, has been made pernicious to public and private rights, and "dominates" them by certain imported incidents, viz., by—

I. Land-grants.
II. Pools.
III. Construction companies.
IV. Rebates and discriminations.
V. "Fast-freight lines."

Mr. Hudson does not add to these—sleeping, hotel, and parlor-car companies, railway-lighting companies, and all the numerous other auxiliaries to modern railway management, which save the time and economize the capital, while they accommodate the patronage of railways. I know not why, but, since he has left them out of the indictment, we will follow his example. But Mr. Hudson does pause just here—by what logical process is not apparent—to fulminate to the length of many solid pages over and against the Standard Oil Company, its history, career, and the procedure by which, before the days of "pools," it was able to force favorable contracts upon the railways to its own vast advantage; accumulating thereby assets almost as enormous as either of the three or four private fortunes in which Mr. Hudson sees such imminent peril to the republic. As we are just now considering the railways, perhaps we might as well leave out the oil company. We may admit, I think, however, in passing, that the Standard Company was an accident—a thing by itself, like the moon or the Gulf Stream—from whose existence even a possibility of another can not be predicated, since the present system of "pooling" associations would render its repetition practically impossible. Mr. Hudson is perfectly right in announcing that this great corporation is not a charity or an eleemosynary foundation of any sort; that it does business for the enrichment of its own stockholders rather than in behalf of those of its rivals; that it takes all it can get—is soulless, grasping, and selfish. That it has been engineered by men of brains until it has become in certain localities a practical monopoly may also be conceded. That, so long as the laws under which it is incorporated permit other incorporations for like purposes, it is a monopoly, legally or derivately speaking, I am afraid must be denied.

Premising merely that railways are not always the personal property of their officers, but that their ownership, as a rule, shifts with every sale of stocks made in Wall Street or on the 'Change of a dozen capitals—and that, in Mr. Hudson's formula (page 5), "of the exist-

ence of actual abuses in the railway system of the country there is little room for dispute," it were not impossible to substitute for the term "railway system of the country" the term "everything human" —let us pass to the counts of the indictment:

I. LAND-GRANTS.—Of these Mr. Hudson says: "We might even make allowance for the men who, having received a gift of an empire of lands and money for the construction of a transcontinental railway, proceed to bribe legislators and buy up public officials to prevent adverse action as to the ratification of past donations. . . ." (page 6). "If the Government has secured the settlement of the Western Territories, the pacification of the Indians, and quick transit to the Pacific coast, by giving the men who built the transcontinental railways the money to build the roads, and an empire of land in addition, it is still permissible to ask whether it will not suffice to present the projectors of the next enterprise with the completed railroad, without adding the millions of acres of territory to induce them to take the gift" (page 8). This is hardly in what might be termed "the scientific spirit." But let that pass. The point is, does Mr. Hudson know what a land-grant is? In the free and buoyant West, where language is as bounding and breezy as its own prairies, a land-grant is often spoken of as a "land-grab." Mr. Hudson is more choice in his phrase, and calls it simply and grandly, a gift—a "gift of empire"—but his idea appears to be much the same. If the Government makes one a gift of land, that ought to be the end of it, by every principle of morality and justice, if not of politics. The Government is just as much bound by its gifts (barring the rule of construction to be noted) as any other giver. But Mr. Hudson says it is not a gift, exactly; but "a gift . . . for the construction of a transcontinental railway." Those who have tried it have been heard to affirm that "the construction of a transcontinental railway" is a matter of some considerable magnitude, requiring time, perseverance, and even labor. The Government, then, makes men a gift to build a transcontinental railway much as Mr. Hudson would make a builder a gift to build Mr. Hudson a house; and Mr. Hudson will even "make allowance for" men who will bribe legislators to prevent adverse action as to ratification of such a gift as that! Bribery is an intolerable crime; of all crimes most subversive of the public weal. But if bribery were ever, or ever by any possibility could be, justifiable as a last resort, it seems to me it would be justifiable to prevent adverse action by legislators who were determined to prevent the Government from ratifying a gift of land to men who had relied upon its honor and good faith even to such a trifling extent as to build a mere transcontinental railway! If the Government gives Mr. Hudson land, surely it ought not to take it away again, ratified or unratified. But, if it it gives him land in consideration of labor and services rendered and material furnished, and he deliver the material and perform the labor and services, surely he ought not

to be put to the peril of the Government's refusal to ratify the gift, or to the expense of bribing legislators. But if Mr. Hudson had received a gift of lands (and even "an empire" is not—some who have attempted it say—too great for the task) in exchange for the construction of a transcontinental railway, from the General Government, I think, on reflection, he would consider himself harshly treated if, on constructing the same, the Government should withhold ratification of its gift. And if Mr. Hudson, why not a railway company?

But what is a land-grant, or "gift of an empire," since Mr. Hudson prefers that term? To begin with, it is a devotion or dedication of a certain portion of the public domain to railway purposes. Instead of purchasing it at two or three dollars an acre, the railroad company purchased it by building a railroad; not where and when they pleased, but between certain points, perhaps even through mountain-ranges, no matter how great the difficulties or how costly the construction, tunnels or viaducts, banks or bridges; not at their leisure, but in good faith as nearly within a specified time as human industry and allowance for the uncertainty of human events, financial and physical, would permit. Surely, this is no "gift" or "grab," to begin with. But, on building this railroad, does the land thus "given" become the property of the company? Not yet. There are other details; the land must be surveyed by Government surveyors, and the company must pay the cost of the survey in cash before it can take possession. Even Government surveyors do not work for nothing, and land in its native wildness, where human foot hath scarcely trod, is not apt to recoup much of engineering expenses. Nor is this all. If there happens to be upon the "empire" of land (which is granted by the square mile, and without reference to any map, or former record of grant, by general description in terms of quantity only) any acre or plot already occupied by an individual, Indian tribe, or other company, does the Government guarantee its own "grant of empire" given to this company as a consideration for the labor, services, and material it has exhausted in building a transcontinental railway? Strange as it may seem, the Government not only does nothing of the sort, but in its own general land-office sits as arbitrator between this earlier proprietor or these earlier proprietors and its own grantee, upon its own grant; and appeals to the rule (first laid down by Lord Ellenborough) that, whereas a private grant is to be construed strictly against the grantor, a public grant, from a state to a subject, is to be construed strictly against the grantee! This matter (in which the Government's grantee is made that unusual character, a defendant with the burden of proof) is tried before the grantor Government, is heard by the commissioner whose decision is to be affirmed or reversed on another hearing before another employé of the grantor, the Secretary of the Interior. Or should the contesting proprietor or alleged proprietors elect to begin his or their action for trespass in the local State or Territorial court, it can be car-

ried step by step up to the Supreme Court at Washington. As a matter of fact the reports of this court teem with these cases, wherefrom the reader can imagine something of the routine litigants have undergone to get there. All these hearings and rehearings, appeals and new trials, and further appeals, have to be attended and argued by counsel in behalf of the Government's own grantee, the defendant company. And since, should the company finally secure its title to the land the Government had already granted it, it can only sell it for two or three dollars an acre, and lawyers' bills are not apt to be prepared on a *diminuendo* scale, the public mind can now begin to appreciate how recklessly magnanimous a "gift" this land-grant was on the part of the Government, and the extent of Mr. Hudson's charity in being able to "make allowance" for the recipients!

But the above is not all. This gift, Mr. Hudson himself admits, has to be ratified, and legislators bribed to ratify it. He would come nearer the truth did he assert that it has to be ratified at every session of Congress. I have in my mind a company whose land-grant was received considerably more than twenty years ago, and which has earned it by building and operating its entire road, and yet I doubt if the lawyers of that company could, without considerable research, mention a year in which that grant had not been a matter of attack upon the floor of Congress. Nor is it yet at rest there, although that road is operating over three thousand miles of trackage. Mr. Hudson says that the men who receive these dubious "gifts of empire" "bribe legislators and buy up public officials," to prevent adverse action as to the ratification. Doubtless he knows of what he speaks. Our legislators are elected by the people, and to the people they are responsible. But the fact that our legislators do not, as a rule, allow land-grant questions to rest, and are constantly demanding adverse action, even in cases as old as the one I have just referred to, does not look as if land-grant companies had largely added to the expense of receiving their already costly present of lands by large "bribes to legislators and purchase of public officials"; for certainly they have not prevented adverse action upon these grants to any very memorable extent.

Mr. Hudson speaks of money-grants as well as land-grants to a transcontinental railroad. In the throes of a bloody civil war it is to the eternal credit of one patriotic Congress that it did vote a loan to a transcontinental railway company to enable it to connect the shores of two oceans whose communications otherwise were at the mercy of pirates and privateers, fitted out by a rival nation, interested in driving our commerce from every sea. But, with the necessity, the policy ceased forever. In other cases, to make their heavily purchased "gifts" available, the plan of mortgaging them was resorted to. They have been so mortgaged, and, on the faith of the Government, the bonds secured by these mortgages are now held by this people;

this republic—whose enemies, Mr. Hudson will have us believe, all railways are. Nor is it a figure of speech to say, in this case not only, but in every case of a railroad upon which a mortgage is spread, that so far from the railway being the enemy, it is the creature of the republic, for the republic is the people, and the people, by owning the securities of a railway, own the railway itself. Mr. Hudson may fire the popular heart of the non-investor by his periods; but if, perchance, he desires more than this, he can not yet claim to have found either a place to stand, or a fulcrum for his lever.

II. Pools are combinations of railways at once with and against each other, never against the public, or (if Mr. Hudson prefers) the republic. The name is unfortunate, as suggesting a pot or lump, whereas, in fact, the pool is an elaborate system of differentiation and equating, by which railroads practically pay into the pool, not their lumped receipts, but percentages thereof. These pools are the legitimate and necessary results of the rechartering over and over again of railway companies to transact business between the same points, by paralleling each other. So long as the people in their Legislatures will thus charter parallel lines serving identical points—thus dividing territory they once granted entire—it is not exactly clear how they can complain if the lines built (by money invested if not on the good faith of the people, at least in reliance upon an undivided business) combine to save themselves from bankruptcy. Without such combination the strongest company must bankrupt and "gobble" the others, which survival of the fittest would be exactly what Mr. Hudson declaims and deprecates—a Monopoly; and this time a most grasping and cruel one, since the first aim of the surviving road must logically be to recoup itself for the tremendous expenses of the "gobble" by extravagant overcharges! Had a pooling system existed at the date of its birth, the Standard Oil Company octopus could never have grown up. And it is interesting reading—as Joe Gargery would say—to find our Mr. Hudson snarling on one page at railways because they render such monopolies as the Standard Oil Company possible, and, on the next, cursing pools as against public interest. And not only are pools safeguards against private monopolies, but, as against the "tie-up" and the boycott, bound to become the needed, possibly the only, antidote if not the only relief, possible. Individuals may, and no doubt do, from geographical conditions, suffer from the absence of competition which pools guarantee. Doubtless a shipper at Buffalo could make better terms to New York were five trunk lines engaged in the suicidal pastime of cutting each other's throats. But the greatest good of the greatest number is subserved by an honest rate, and that the pool secures to it.

III. Construction companies are conservers of time and capital at once to the public and to the railway-builder. If a railway between two given points be needed at all, it is needed as soon as possible.

The construction company, by procuring the capital, obviates the delay of resorting to individual subscriptions, and the dilatoriness of small subscribers; and, by securing a rapid building and equipment of the desired road, serves the public by affording them early transportation facilities. And if, at the same time, it secures the stockholder and builder by relieving against the reasonable probability that a railroad built to develop new territory would pass into the bondholders' or into a receiver's hands before the territory could be developed, the benefit to the stockholders ought not reasonably to be considered an offset to the benefit to the shippers.

IV. Rebates and discriminations are neither peculiar to railways nor dangerous to the "republic." They are as necessary and as harmless to the former as is the chromo which the seamstress or the shop-girl gets with her quarter-pound of tea from the small tea-merchant, and no more dangerous to the latter than are the aforesaid chromos to the small recipients. The trouble Mr. Hudson finds with them is that the railway systematizes them instead of granting them at random or for sentimental reasons. The *quasi*-public character of railways, he thinks, should make these rebates illegal. The railway, in exchange for its right of eminent domain, should listen to the wants of the whole people instead of to individuals. Undoubtedly. But the whole people are not shippers over any one railroad; nor does any one railroad draw its revenue from the whole people. Of course, I am proceeding upon the supposition that the United States Government does not propose to become a gigantic railway corporation, and add to its legislative, judicial, and executive functions the operating of 125,379 miles of railway, with a funded debt of $3,669,115,722. Did "the republic" undertake such a task, does Mr. Hudson, after reading his own book, believe that there would be no rebates or discriminations extended to anybody for political, economical, or social purposes?

V. The subject of "fast-freight lines" might well be dismissed in the same breath, these being a financial consideration entirely between the companies and their stockholders. It may be noted, however, that they are public accommodations, affording to large parcels the safety, care, and prompt delivery which express companies afford to small ones, and that, like the express companies, they have grown to be public necessities. They not only secure the delivery of freight at destinations beyond the receiving line, but have introduced new amenities into civilization by distributing products. By their aid the New-Yorker finds daily on his table the fruits of California, or the glorious beef from Texas grazing; and the dweller in the lake-shore States his sea-food, as if each had changed places with the grower and gatherer. Nor do the figures show an increase, but, paradoxical as it may seem, a substantial decrease in tariffs on non-perishable freights by their means.

Stripped of declamation, this is all there is of Mr. Hudson's counts:

the result being, that while railroads are not philanthropic or charitable bodies, organized for good works among the poor and needy, they are not basilisks, or gorgons, or minotaurs, destroyers of the state or dragons that feed upon the people. And now we might well leave Mr. Hudson and all his works, were not his lack of standpoint just here so ludicrous as to tempt from us a further word. He cries (page 9), "Railway projectors have invariably embarked in these enterprises, not so much for the public welfare as for their own private enrichment." What else had Mr. Hudson been led to suppose? The millennial state in which private enterprises are conducted for public ends is certainly not yet a State in the Federal Union, wherever else on this planet it may be discovered. Mr. Hudson's next proposition is that, "if the country has had hundreds of millions added to its wealth by railway construction, the builders have also secured tens of millions for their individual fortunes." In any but the millennial state one would think that a free gift to the commonwealth of ninety percentum of one's profits was a rather liberal tithe, and an exceedingly handsome thing. Most private parties, certainly most governments, would open their coffers to their friends on the same terms. But Mr. Hudson is ashamed to think that private capital, enterprise, patience, and labor should have been returned anything. Clearly, the Government should take fully cent per cent for the industry of its subjects.

"While the nation has gained in wealth and population by the general extension of railways," says Mr. Hudson, "it does not follow that the wealth could not have been more justly distributed if railway management had been universally governed by the principles of equity" (page 8). What wealth? Mr. Hudson was just now complaining that the entire benefit did not go to Government, and that the individual received ten per cent. Now he regrets that it was not even more widely distributed among individuals. What are Mr. Hudson's views as to the meaning of the word "equity"? Would "equity" have been subserved if the ten per centum or the hundred per centum were distributed by lot, or on a basis of pauperism, or covered at once into the treasury of the republic? The statements that "the equality of all persons is denied by the discriminations of the corporations which the Government has created"; that "under them the increase of national wealth is not distributed among all classes according to their industry and prudence, but is concentrated among those who enjoy the favor of the railway power"; and that by means of railways "general independence and self-respect are made impossible" (page 9), may perhaps be passed over with the remark that if Mr. Hudson himself believed in propositions as silly as these, to argue with him at all would be like reading Herbert Spencer to the Salvation Army.

It is a *bonne bouche* to bring into the discussion at this point an

allusion to the riots of 1877 in lurid juxtaposition with the French Revolution; but—since, wherever planted, the roots of neither of these cataclysms lie in land-grants, construction companies, pools, rebates, or fast-freight lines—it need not detain us here. I have not touched in this paper upon the "Granger" cases (so called), my limits forbidding. But I do not understand that the principles enunciated in them conflict with any of the statements I have made. I lately had the pleasure of perusing a learned article in an English magazine which proposed that railway companies, like post-office departments, make rates independently of distances or extent of services rendered; or at least establish two rates, "one for short distances and others for long distances: so much for every distance not exceeding one hundred miles, so much for every distance between one hundred and three hundred miles, and so much for all distances exceeding three hundred miles, keeping the one rate for all distances in view as the ultimate object." It seems to me that, if gentlemen who write in this fashion expect their papers to be read, they expect all they are entitled to. Similarly, I think that Mr. Hudson's loving treatment of the ancient claim that, since railways are public highways, any citizen has a right to send his own limited express along the line at any moment on payment of a trackage-fee, ought to stamp the value of his criticism. But since many of his terrors do very widely obtain among conscientious men, I have thought to attempt to allay them. Mr. Hudson's book is printed on better paper and more nicely bound than the usual socialistic attack upon things as they are. But that he is, or is destined to become, the long-looked-for reformer of the American railroad, I fear can hardly be hoped.

A MOUNT WASHINGTON SANDWORT.

By GRANT ALLEN.

WE were not fortunate with our plant-hunting on Mount Washington. Perhaps, for want of a local botanist to show us the lurking-places of the rarer species, we did not succeed in finding all of them. But some of the most interesting to a British naturalist could be gathered everywhere without the trouble of seeking. When the little, puffing, oblique locomotive that drags you up from Marshfield to the summit stopped awhile to rest and refresh itself after its steep climb up Jacob's Ladder, we jumped out eagerly upon the surface of the mountain; and there, among the erratic bowlders of the Great Ice Age, I lighted at once upon broad beds of two plants my eyes had never before beheld in the living state—one, a pretty tufted White Mountain sandwort, and the other a beautiful bright golden avens. So thickly did they cover the ground on that high shoulder of the

great ridge, that all the passengers were filling their hands with big nosegays to carry away as mementoes of the mountains. The sandwort in particular starred all the crannies among the rifted rocks with its delicate blossoms, and brightened up the otherwise bare and forbidding soil with the mingled green and white of its densely tufted bunches. *Arenaria Grœnlandica* is its scientific name—a name that tells at once the better part of its curious history; for this little plant belongs by rights to the frozen shores of far northern Greenland, and the little colony that lingers on here in the clefts of the rock has lived on the chilly summits of the White Mountains ever since the close of the Glacial Epoch.

There are many other flowers on the slopes of Mount Washington far more full of interest to the American botanist than this Greenland sandwort, because far more isolated in the New World, and far more difficult for him to find elsewhere. The sandwort occurs abundantly on several other mountain-summits in the States, being found on the Shawangunks, the Catskills, and the Adirondacks, as well as in the Green Mountains and on the higher peaks round Lake Memphremagog. At Bath, Maine, it even appears on river-banks near the sea, and farther northward, in Labrador and Greenland, it becomes a common plant of the plains and uplands. But the Alpine brook saxifrage (*Saxifrage rivularis*) confines itself in the States entirely to Mount Washington, as its beautiful congener, the purple saxifrage (*S. oppositifolia*), does to the rocky crags of Willoughby Mountain in Northern Vermont. So, too, the little creeping mountain potentilla of the Scotch Highlands (*Sibbaldia procumbens*) is only found in the United States on the Presidential Range of the White Mountains. There are many of these Alpine or sub-Alpine plants which the American botanist can pick here, and here only, unless he chooses to wend his way to the frozen shores of the far North in chilly Labrador and the Hudson Bay Territory. Yet, to the English naturalist, they are comparatively uninteresting, for they form part of the common European mountain flora, which reappears on all the higher peaks of his own continent, from the Alps and the Caucasus to the Norwegian fjelds and the Scotch Highlands. To him, then, these two native American upland plants present far more numerous points of interest, because this is the only place in the civilized world where he can hope to find them ready to his hand, as representatives of the truly northern New-World flora.

The general aspect of vegetation on the higher levels of the White Mountains, indeed, is distinctly subarctic, or, to give its truer name, as I prefer to say, glacial. Besides the common sun-dews and the grass of Parnassus, which always follow the upland bogs of northern climates on both sides the Atlantic, Mount Washington and his neighbors possess a large number of chilly plants, like the Norwegian cloudberry (*Rubus chamœmorus*), the Alpine willow-herb (*Epilobium Alpinum*), the dwarf rattlesnake-root (*Nabalus nanus*), the mountain

cudweed (*Gnaphalium supinum*), the bog bilberry (*Vaccinium uliginosum*), the Alpine bearberry (*Arctostaphylos Alpina*), and the Lapland phlox (*Diapensia Lapponica*). Some of these, and others like them, were old friends already familiar to me on European mountains; but some were fresh American acquaintances, whose faces I was glad indeed to see on these bald summits. Both types, however, were alike in their thoroughly northern and almost arctic aspect; they were the plants of Greenland, of Finland, of the North Cape in Norway, of frozen Rupert's Land, of equally frozen Siberia. Some of them were common to both hemispheres, some were peculiar to the New World, but all, indiscriminately, were members of that same old circumpolar flora which came into being at the extreme end of the Pliocene period, when the world was just beginning to cool down at its extremities for the long secular winter of the Glacial Epoch.

Traces of that gradual cooling down are by no means wanting in the geological deposits of either hemisphere. The Pliocene period, as a whole, both in Europe and America, was an age of warm and genial climates, of large and vigorous animal types, of rich, sub-tropical-looking vegetation. In the Red and Norwich crags of England, for example, we find the remains of mastodons and elephants, of hipparions and hyenas, of the hippopotamus and the rhinoceros, of the tapir and the horse. In the rich leaf-beds of the nearly contemporary Vienna basin, we meet with a correspondingly warm sub-tropical flora—a vegetation abounding in sequoias, liquidambars, and chestnuts, fragrant with cinnamon, laurel, and tamarind. In the Loup River beds of the upper Missouri region, again (Professor Marsh's "Niobrara group"), America possesses similar mammalian remains of tropical and almost Oriental character—a tiger larger than the Bengal beast, an elephant, a mastodon, several rhinoceroses, and the earlier sketchy prototypes of the camels and the horses. The period when such warm-weather creatures flourished in such northern latitudes must surely have been one of very genial climatic conditions. But, toward the close of the Pliocene age, mutterings and forewarnings of the great glaciation begin to show themselves, and to herald the advent of that vast ice-sheet which gradually swallowed up in its devouring bosom the better portion of either continent.

Already in the Norwich crag of England the evolution of such northern molluscan species as *Scalaria Grœnlandica*, *Panopœa Norwegica*, and *Astarte borealis* (whose very names attest their arctic habits in our own day), gave evidence of a slow but certain lowering of the world's temperature. Nature only produces these cold-weather types where the surrounding conditions have rendered the change absolutely necessary. In the somewhat later Chillesford beds, the great invasion of arctic kinds begins in earnest; about two thirds of the shells whose fossil remains form the fauna of the period still survive in high northern waters. Slowly, as the period of greatest eccen-

tricity drew nigh, the ice-cap began to form around the north pole. From the Arctic Ocean, the great sheet of solid glacier descended over Canada and the Eastern States till all New England, New York, and Pennsylvania lay covered with five thousand feet thickness of unbroken crystal. The ice cleared all animal and vegetable life off the face of the earth wherever it rested, and drove before it the old arctic fauna and flora as far south as Maryland, Virginia, and Kentucky. After many minor chances and changes, however, brought about by the recurrent cycles of summer and winter in the northern and southern hemisphere alternately, the world's weather began slowly to improve again. Step by step the ice retreated northward once more, till at last only the comparatively insignificant polar cap remained to bear witness to its sway, with a few casual southern extensions, like the one that still envelops all upper Greenland in its desolating sheet. As it slowly retired, the arctic fauna and flora followed close in its rear, on both sides of the Atlantic, till nowadays the plants and animals which once covered the plains of Europe, Canada, and New England find their last home in Spitzbergen, Nova Zembla, and the extreme northern shores of British America.

They left behind, however, some tokens of their presence to the present day even in the lower latitudes of Europe and America. The Greenland sandwort, among the New Hampshire hills, is just as much a relic of the Glacial Epoch as the striated rocks, the erratic bowlders, and the coarse drift which the Great Ice Age stranded high up the slopes and corries of Mount Washington, where we still find them in our own times. All the other glacial species (including that rare White Mountain butterfly which occurs on the very summit of that one peak, and nowhere else south of Labrador) have struggled on side by side with it, in isolated colonies, from the days when the ice retreated northward to the present moment. But there is a great difference in this respect between Europe and America, as Dr. Asa Gray has well pointed out. With us, in the Old World, great lateral ranges of mountain—Alps, Pyrenees, Dovrefjeld, and Caucasus—still nourish large existing glaciers and snow-fields, the lineal descendants of the universal ice-sheet of the Glacial Epoch. Hence, our European mountain flora, and, to a less extent, our mountain fauna as well, are even now large and flourishing; they retain a marked arctic appearance, and recall all the well-known stunted features of the glacial assemblage of plants and animals. The snowy mountain regions have acted as continuous nurseries for the dwarfed vegetation of the Great Ice Age. In America, on the other hand, you have few hills of any size east of that great backbone of the continent, the Rockies, and none of these hills rise to anything like snow-level. Hence, your mountain flora is, on the whole, but a poor one, and most of the species are the familiar kind which the European botanist already knows well among the Swiss Alps and the Scotch Highlands.

Mount Washington, indeed, though the highest of all your North-eastern peaks, is not by any means the best station in the States for the plants of this old stranded glacier stratum. As you go from New York to Montreal by the Memphremagog route, you pass near St. Johnsbury a little station named West Burke, whence stages carry you in a few miles to Willoughby Lake, one of the loveliest among all the lovely sheets of water with which Northern Vermont is so copiously dotted. The hills surrounding Willoughby Lake are rich in mementoes of the Glacial Epoch. There, alone in the States, thanks to combined latitude and elevation, the American botanist can pick at leisure the beautiful tufted mountain saxifrage that purples with its bloom the Highlands of Scotland in early spring. There, too, grows its pretty yellow congener (*Saxifrage aizoides*), a circumpolar species of both hemispheres, which descends in Europe as far south as the Cambrian lakes. The Alpine rock-cress, the hoary whitlow-grass, the purple astragalus, and many other high northern species, are also almost confined in the States to Willoughby Mountain, though reappearing far to the north in British territory—either Canada or Newfoundland. Mount Katahdin, in Maine, ranks next as a refuge for many good glacial species, including the beautiful little starry saxifrage (*Saxifrage stellaris*), whose slender blossoms spread in countless numbers beside the rills and streams of the Scotch Highlands.

Naturally, however, to a European visitor, such a plant as the Greenland sandwort possesses a far deeper interest and importance than these old friends of the Swiss or Scotch uplands. It is a native American, local to the soil; or, to speak more correctly, a rare example of a glacial plant which has died out in distant Europe in spite of the superior advantages there afforded to Alpine or sub-arctic species, while it has lingered on in vigorous colonies over all the fitting districts of America, from the riks of Greenland to the Catskills of New York. Nay, more, in a slightly altered and adapted form, as the *Arenaria glabra* of the systematic botanists, it has held its own even as far south as the mountain-tops of Carolina—a glacial strayling stranded almost alone on the chilliest summits of a sub-tropical land. The Carolina type, as might naturally be expected, is a larger, handsomer, and more luxuriant plant than the New Hampshire and Greenland variety, but it does not differ in any point of real structural or systematic importance from its pretty little sisters of more frozen climes.

Very much the same thing is true of our other common Mount Washington flower, the yellow avens that grows so abundantly in and out among the thick-set beds of Greenland sandwort. This, too, is a thorough-going native American type, though not a type of glacial antecedents. What gave it its deepest interest in our eyes was the very fact that, growing as it did side by side with those sub-arctic plants, the bog-bilberry and the mountain saxifrage, the Alpine bearberry and the Lapland phlox, it yet exemplified the other main ele-

ment of the American upland vegetation—an element intrusive from the southern mountains rather than from the circumpolar and northern plains. For the avens is, in fact, a New England mountain variation on a pretty plant which covers the higher Carolina hills—*Geum radiatum* of Michaux, a hairier representative of the self-same type. The more northern outlier, known as the variety *Pechii* of Pursh, has smoother leaves and somewhat glabrous stems, but otherwise keeps up the general characteristics of its Southern congeners. Just so, on the slides above the Notch of the White Mountains, not far from the Willey House, I found in profusion another essentially Southern plant —the *Paronychia argyrocoma*, a silvery looking whitlow-wort, whose inconspicuous blossoms, allied to those of our European knarvel, are yet rendered beautiful and noticeable to mountain insects by their numerous thin and shining scarious bracts. This curious plant, one of the most suggestive I found in America, is not known to occur anywhere else in the far Northern States save in this one deep and secluded valley. But, among the Alleghanies, it occupies every breezy summit from Virginia southward, so that it belongs, like the Mount Washington avens, to the sub-tropical mountain flora, and only makes its appearance, as if by accident, among the glacial vegetation of the New Hampshire hills.

How did these isolated Southern species come to obtain a footing in such bleak situations near the northern limit of the United States? Doubtless, in the first instance, their introduction was due to the agency of casual birds, who must have brought the seeds with them, clinging to their feet or legs, on their annual migration from their winter dwelling-places. Once fairly started on the New Hampshire mountains, they succeeded well because naturally adapted to their new situation, where the summer heat would not be far inferior to that of their native Carolinian heights, while the snow-sheet of winter would amply protect them from the killing effects of December frosts.

And this brings us back once more to the point from which we started—the history of our little Mount Washington sandwort. Nothing was more noticeable, as we mounted the slopes on the cog-wheel railway, than the wide sheets of conspicuous blossom that greeted us everywhere with their striking mass. First of all, it was Canadian cornel in broad patches that whitened the soil; then it was great areas of the Greenland sandwort; and then golden spaces of the yellow avens. Now, all the world over, mountain-plants, especially those that grow beyond the limit of trees, and close up to the very snow-line, are celebrated for their exceptional display of vivid color. Everybody must at least have heard of the Alpine gentians, globe-flowers, and daffodils, that belt with blue or gold or primrose whole zones of mountain-side in Swiss spring-time. Exactly the same thing is true of the arctic flowers; short as is their summer, they make it

beautiful while it lasts, with their profuse bloom, a hundred times more vivid and pervasive than anything to be seen in those much overpraised and misrepresented tropics. Even in temperate Europe and America, everybody must have noticed that, as we go up the higher hills, we find their slopes purpled with heather or golden with gorse, pink with mountain-laurel, or crimson with masses of the wild rhododendron.

Why is this? Simply because among the uplands and more especially close to the snow-line, bees are rare, and the work of fertilization is mainly left to the care of butterflies. Now, the bee, as everybody knows, is a steady, regular, business-like worker: he flies low, hunts close, never mixes his liquors, sticks steadily to one kind of honey produced by one species on each journey, and looks carefully for his selected blossom in and out among the tangled vegetation of meadow or road-side. Hence the flowers that specially cater for his peculiar tastes are more remarkable for their exact adaptation to his size and shape than for any conspicuous floral display. But the butterfly, on the other hand, is well known to be a fickle, flitting, fantastic creature: he flies high from bunch to bunch of large and noticeable bright-hued flowers. Above all other members of the insect tribe, he is a lover of color: big patches of red or white or purple are the things to attract him from a distance with their massive glare, and to draw him down from his careless flight in the eye of heaven. Hence butterfly flowers generally grow in huge trusses, massed closely together to re-enforce one another's effect; and they produce the finest total displays of any species known to humanity. On the hill-tops, and especially close above the limit of trees, the high-flying butterflies have things all their own way. The plants that affect these chilly situations, therefore, have before been compelled to accommodate themselves to the circumstances, and to trust for fertilization to the stray attentions of the casual butterfly. It is not without reason, then, that on the summit of Mount Washington a specialized and peculiar glacial butterfly should still accompany the specialized and peculiar glacial flowers.

Our Greenland sandwort, indeed, may be taken as a very good representative of the qualities necessary for ultimate success in a high-mountain plant. It grows low, in densely tufted masses, unlike the majority of its family, the *Alsinæ;* and thus it escapes both the rapid winds that career so madly round the summits of the Presidential Range, and the frosts of winter from which the snow efficiently protects its humble branches. Its blossoms rise in immense numbers from every tuft, so as to whiten the ground wherever it grows; and the petals are immense for the size of the plant, to act as an advertisement to the passing butterfly. Turn from it for a moment to the beautiful moss-campion (*Silene acaulis*) which grows close by among the crannies of the Mount Washington rocks, and you get a precisely

similar assemblage of mountain features. That dainty little plant is tufted like a moss; its leaves are as crowded as those of the sandwort, and similar in shape, for like conditions always produce like results; and its purple blossoms grow in exactly the same wild profusion, making the whole plant, during the flowering season, into one low mat of brilliant bloom. The moss-campion is a perennial, and its close habit and much-branched, creeping stem protect it from the severe winter of New Hampshire, as from the Scotch snows and the frosts of Switzerland. We have in Europe another precisely similar plant, the Alpine lychnis, which one might almost at first sight confuse at a distance with the moss-campion, so absolutely have they accommodated themselves in the same way to the same environment; and this pretty pink flower, with its compactly clustered heads, has survived only on two hill-tops in the British Isles—Little Kilrannoch, a mountain in Forfarshire, and Hobcartin Fell, one of the least visited of our Cambrian heights. Compare the case of the glacial American species which still loiter round Willoughby Lake, or on the frozen heights of Mount Katahdin in Maine.

Every one of these mountain-plants exhibits in perfection the self-same familiar mountain characteristics. Take, for example, the white dryas (*Dryas octopetala*), a species of interest to American botanists from the fact that in Pursli's time it still grew among the White Mountains, though it has now disappeared entirely from the United States, and can not be discovered south of Lower Canada. (Such local disappearances, by-the-way, are everywhere common, more than one rare local plant having been expunged from the British flora within my own memory.) The dryas is a dwarf and matted perennial herb or undershrub, growing in tufts just like the moss-campion, and with starry white flowers to match the Greenland sandwort. Its short and much-branched stems creep close upon the ground; the prostrate branches are crowded with dense foliage in spreading tufts. The species, in fact, with the rest of its kind, is but a specialized mountain form of avens; and its flowers are white, not yellow, like most of the avens group, in special adaptation to the butterfly taste; for it is a noteworthy fact that many genera which are yellow in the lowlands tend to produce white and purple species when they rise among the mountains or near the Arctic Circle.

The moss-campion is a pink by family, while the dryas is a rose. Now look once more at a member of a totally distinct order, the Lapland phlox, which also grows among the ice-worn bowlders of the Presidential Range. The phloxes as a whole are tall and handsome, large-leaved plants; but the mountain kind (*Diapensia Lapponica*), that still lingers on among the New Hampshire heights and the higher Adirondacks, is an Alpine dwarf evergreen, growing in the regulation dense convex tufts, a perfect mat of intricated leaves, from whose little rosettes rise solitary large white blossoms, as handsome as the

dryas, and not unlike it in general effect. Anybody who cultivates rock-gardening, indeed, must be thoroughly familiar with this curious mat-like habit of the northern mountain flora; for many of the saxifrages, alyssums, arenaries, and stone-crops which form his favorite masses of bloom are members of this truly Alpine and sub-Arctic vegetation. Often their very names betray their origin: lovers of rock-gardens will know what I mean when I mention such cases as *Erinus Alpinus*, *Lychnis Lapponica*, *Sedum Kamschaticum*, *Alyssum montanum*, *Silene alpestris*, *Dianthus petræus*, *Saxifrage nivalis*, and *Arenaria montana*.

Nor is it only herbaceous species that undergo this curious dwarfing and acquire this strange matted tuftiness, in order to meet the needs of high Arctic and Alpine situations. Trees and bushes have similarly to accommodate themselves to the exceptional conditions of the snow-line and the region just below it. Every tourist who goes up Mount Washington must have noticed how, near the limit of arboreal vegetation, the pines and spruces grow shorter and more stunted by slow degrees, till at last they disappear altogether from the scene. But even after they are gone, so far as the naked eye is concerned, they persist in part for the eye of the botanist. Three dwarf willows, for example, occupy the summits of the White Mountains, beyond the so-called limit of trees. All of them are prostrate, matted, and Alpine in type; none of them rises above the general level of the herbaceous vegetation in whose midst they are found. The first, known as Cutter's willow, may also be gathered among the other higher mountains of the extreme Northern States, such as the Adirondacks and the Maine ranges. The second, the silvery-pointed willow, a very pretty plant of glossy, satin-like sheen when young, is confined to the moist Alpine ravines of the White Mountains themselves. The third and most dwarfish species of all, the herbaceous willow, has lost all resemblance of its descent from what was once a forest tree, and has degenerated into a rare ordinary herb, seldom rising above an inch or two from the ground, but still producing from its terminal buds the tiny catkins which keep up the memory of its former high estate. This last degraded scion of the willow stock, which creeps and roots underground for considerable distances, is common to both sides of the Atlantic, being found also in the Alps and Pyrenees, as well as in Arctic and sub-Arctic Europe: but the White Mountains are its only known station in the United States.

It is interesting to note that just the same dwarfing of the trees and shrubs took place everywhere during the fiercest rigor of the Glacial Epoch. In the little bed of glacial clay, containing plant remains of the Great Ice Age, on the coast of Norfolk in England, we still find the leaves of a tiny, shrubby birch (*Betula nana*), which grows even now in the Highlands of Scotland and in Scandinavia, attaining there at times to tree-like size, but which dwindles near the

Arctic Circle to a mere dwarf; and it is the dwarf form whose leaves occur among the glacial *débris* of the Norfolk clay-bed. Side by side with it we find the scanty remains of a stunted northern willow (*Salix polaris*), another of the numerous pygmy shapes which the polymorphous willow type knows so well how to take on under fitting circumstances. It is hard, indeed, to conceive how anybody could ever have watched the gradual stunting of the trees and shrubs, as we ascend a mountain, or approach the Arctic Circle, and yet believe in the separate and deliberate creation of dwarf forms for such great altitudes or high latitudes, like the Mount Washington willows or the polar birch. If we trace the gradual degeneracy of the temperate birchen type, represented by the beautiful American silver or paper birches, through your own shrubby *Betula purinla* of the Northern bogs, and your petty *Betula glandulosa* of the high mountains, to the insignificant *Betula nana* of the arctic regions and of glacial times, it is impossible not to recognize in the entire series one long degradation of a primitive form. Similarly in the willows: every intermediate step may easily be identified, from the large and handsome weeping-willows, through shrubby forms like *Salix Lapponum*, *Salix refens*, and *Salix myrsinites*, till we reach at last the final term in the tiny *Salix herbacea* of the White Mountains. All are species degraded from a tall and vigorous ancestral tree by the harsh conditions which prevailed at the coming in of the Glacial Epoch.

The shrubs, of course, have fared no better than the forest-trees; but, like the forest-trees themselves, and the lowly herbs, they have learned to accommodate themselves to the situation. Thus the bramble kind, after growing down from the high blackberry and the black raspberry to the level of the trailing dewberry (*Rubus Canadensis*) and the dwarf raspberry (*Rubus trifloms*), reaches at last an almost herbaceous type in our British *Rubus saxatilis*, and finally ends in a mere herb, no bigger than a strawberry-vine, in the true cloudberry of the arctic regions and the New Hampshire hills. So, too, the cornels, starting with your glorious flowering dogwood (*Cornus florida*), which alone is worth a visit across the Atlantic to see, ends at last in the pretty little bunchberry (*C. Canadensis*) that carpets the woodlands of the high North. And so, once more, the heath family, starting from the noble rhododendron and mountain laurels that glorify and brighten your American hills, tails off at last into the low, spreading, and tufted bog-bilberry, confined entirely to Alpine tops on both sides of the water, and to the mountain bearberry, whose low mats cover the interstices of the rocks among the White Mountains and the higher Maine hills. Everywhere the habit of all these sub-Arctic and glacial plants is just the same, whether their ancestors started in life as trees, or shrubs, or bushes, or herbs; the Alpine azalea is as low and as tufted as the crowberry that mimics it; the Labrador tea is as tiny and as inconspicuous as the Greenland sandwort. On all of them

has fallen the blight of a terrible winter, never yet removed; and all struggle on among the chilly mountains and the northern snow-fields in virtue of that very constitution and character which they derived from their ancestors of the Glacial Age.

BIRDS AND THEIR DAILY BREAD.*

By WILLIAM MARSHALL.

OF all animals, birds possess the quickest motions, the most energetic respiration, and the warmest blood, and they consequently undergo the most rapid change of substance, and need the most food. Although few creatures are so pleasing to the æsthetic tastes of a poetically inclined person as birds, the breeder knows that most of them are to be looked upon as hearty or excessive eaters. Any one who closely observes birds and their conduct will soon remark that all their thoughts and efforts, aside from the few days they spend in wooing and their short periods of resting, are directed to getting something to eat. With what restless earnestness do titmice plunge through the bushes and the trees! Not a leaf is uninvestigated, every chink in the bark is examined for whatever eatable it may be hiding, and a sharp look is cast into every joint of a branch. How industriously does the ousel turn and thrash the leaves on the ground of the woods all the day long, spying its game with a glance of its sharp eye, and snapping it up on the instant! After observing a few such incidents we can easily believe the stories that are related of the fish-eating powers of the cormorant, and of the fruit-eating birds that are able to consume three times their weight every day.

The result of this property of enormous appetite is an intensified activity in the competition for food among birds, and the structure of their bodies and their habits have undergone considerable modifications in consequence of the fact. It is this which has compelled some birds that should be, according to common poetic conception, creatures of the day, to hunt their prey by night. There are many transitions or connecting links between day-birds and night-birds. Day-birds may sometimes be seen pursuing their prey till late in the twilight; and, on the other hand, night-birds, impelled by hunger, will leave their hiding-places while it is still day. Chimney-swallows are often observed of summer evenings circling around high in the air, in company with the bats. The corn-kite is likewise fond of hunting in the dusk, and is late in retiring to its roost. Several owls do not shrink from the clear light, and the *Strix coquimba* of the Chilian coast hunts only by day. Most evidently the northern snow-owl must do its hunting in the bright glare of the sunlight, else, if it were too par-

* Address delivered before the Ornithological Society of Leipsic, February 3, 1886.

ticular about the matter, it would become very hungry during the long polar day.

The orders of night-birds are not very numerous, and only a few plant-feeders are known among them; but many species are represented among the darkness-loving forms, constituting groups like the owls among the birds of prey and the night-swallows, or in single species, like the strigops and apteryx of New Zealand. In the great family of the waders the stone-curlew, the bittern, the snipe, and others are nocturnal, while the black skimmer and the stormy petrel, among the swimmers, partially exhibit the same peculiarity. Those among these birds which have best adapted themselves to the night-life, however little they may otherwise be related to one another, exhibit a number of peculiarities in bodily structure. The eyes of all of them have undergone some obvious modifications. They are large, capable of considerable widening of the pupil, and otherwise especially differentiated in the elements of the retina. A degree of uniformity also prevails in the disposition of the plumage of all these forms; it is monotonous in its coloring, brownish or greenish gray, but never striking or lively, and this for closely related reasons. First, by means of these dull and therefore protective colors night-birds are enabled to live nearly hidden during the day, and are thereby saved from many disturbances and annoyances; and, secondly, because, in the nature of things, sexual selection, determined by the coloring of the feathers, can not exert any modifying influence upon them. What use has the male night-swallow for beauties which the female can not appreciate? The plumage of the real night-birds is also peculiarly soft and dense, so that their movements in the air are almost perfectly noiseless, and so ghost-like in their silence that they are regarded with superstitious awe by the natives of almost every land.

The food itself of birds is of the most diversified character. While some of the tribe are omnivorous, others appear to be adapted to special kinds of food. Usually forms may be distinguished which feed either exclusively on animal or on vegetable meats, or on both. With most birds the last is, in a greater or less degree, the case. Even the so-called "noble" birds of prey occasionally eat berries and herbs when compelled by necessity. Only a few classes of the animal kingdom, perhaps only those which live entirely in the depths of the sea, fail to contribute of their bodies and lives to the repasts of birds; but vertebrates and insects are their favorite game. One bird will eat only living game which it has caught itself, another only carrion, and a third both. Falcons, eagles, hawks, and owls feed upon living, usually warm-blooded creatures; and, while the presence of these may in some cases be regarded as a calamity, it may in other cases be looked upon as a benefit. Altum, by examination of the hair-balls of indigestible remains of food ejected through the mouth, found that the smaller owls are of the highest advantage in agriculture on ac-

count of the prodigious numbers of field-mice they destroy. Yet the farmers kill these benefactors, and nail their skins upon their shed-doors as trophies and admonitions. This is bad enough, even though it be done in ignorance and not in malice. Toads and creeping things are pursued by numerous wild birds—the snake-eagle, the secretary, the curious South American cuckoos called saurothers, and many other feathered foes. The dumb host of fishes finds eager hunters among the birds, even more than among men. Cormorants and pelicans, gulls and sea-swallows, petrels and albatrosses, have made themselves masters of the sea in a higher sense than the most formidable pirate, for the latter is limited to the water, while the birds, not only by swimming and diving snatch the inhabitants of the waters from their own element, but they also capture those fish which, leaving the water for a moment to escape the Scylla of danger from other fishes, throw themselves into the air and into the power of a hungry and greedy Charybdis. And where is any fish in fresh water safe from the pursuit of birds?

No shell or other shelter affords adequate protection to the poor mollusks; but they, too, have to find their way through the maws of birds into the circulating stream of matter. It is true that they usually serve only as a temporary substitute for something else, and few of the inhabitants of the air live exclusively upon them; of these are those curious finches, so like the haw-finch, that live in the Galapagos Islands, descendants from South American castaways, which found no corn-grains on the rocks, but a nutritious though unaccustomed substitute in the shell-fish of the beach, whose shells their tough bills could crack with ease.

The hosts of birds consume immeasurable quantities of insects every day. In no place and no condition are creatures of this class secure from their pursuit. The fat larva, leading a tranquil existence in the depths of decaying wood, is the prey of the sagacious woodpecker. The portly spider, in her dark corner, does not escape the penetrating eye of the redstart. Little beetles and gnats, carried up into the air by ascending currents, are a welcome game to the high-flying swallows.

No more than animals can plants escape the demands of the birds' appetite. Of whatever plants can furnish, excepting only the wood, the birds take their tithes. Humming-birds, besides the nectar, devour the insects that go in after it. The Australian licmetis digs into orchid-roots and lily-bulbs with a bill admirably adapted to that use. The *Polyborus chimango*, of Chiloe, digs up freshly planted potatoes, to the ruin of the farmers, and eats them with relish. Some South American birds feed on aromatic leaves, and the New Zealand night-parrot prefers a delicate liverwort to all other food. But so slight is the nourishing power of this plant that the bird has to consume immense quantities of it, and his crop is swelled out after each meal enormously. Seeds, berries, and fruits furnish a most welcome sub-

sistence to innumerable flocks of birds in all parts of the world. But it makes a great difference to the plant species whether a bird prefers a fruit for its flesh or for its kernel. The yellow thrush and cherry-finch are both fond of cherries—one for the sake of their juicy envelope, the other for the piquant meat of the pits. In the latter case harm comes to the plant; in the former case good. The colored, fragrant, sweet-tasting berries are there to be eaten, and that principally by birds, while the seeds pass out undigested and with vitality unharmed, but rid of their coverings, which would have to be consumed by decay if not eaten, and thereby, in some cases, even better adapted for planting and growing than before.

The birds in this way contribute much to the distribution of plants. For the appetizing reward which they enjoy, they afford the species, if not the single tree or plant, the most important service; and when we say that this bird damages the cherries and that one the grapes, we speak from a selfish point of view that which is fundamentally false, for the birds are ultimately useful to the plants. The Smyrneans call the rose-starling the devil's bird when it visits their fruit-trees in July, and forget that they welcomed the same bird as a saint when it cleared away the locusts in May.

Swallowed seeds undergo a superficial change in their passage through the digestive apparatus, which is, however, not detrimental, but rather, like the maceration which the gardener gives to his seeds, only favorable to their vegetation. Acorns which the nut-hatch has macerated in its crop, when dropped, are much surer to grow than those which the forester plants. Some plants are absolutely dependent on birds for their diffusion, and a kind of mutualism exists between the two—one of those remarkable phenomena in which very different kinds of beings are reciprocally advantageous and adapted to one another. A curious example of such adaptation is seen in the case of the mistletoe and the mistle-thrush. The mistletoe, a parasite of trees, is green and evergreen, though few other parasitic plants are so colored; and the color does not perform the same office to the mistletoe as the green of other plants, for this plant derives its nourishment directly from the sap of the tree on which it is growing without the help of chlorophyl. But it has its uses, one of the chief of which is to attract the thrush to itself. Its fruit-bearing time is when the host-tree has shed its leaves, and it, being all upon the trunk that is green, is conspicuous. Its fruit, a berry, inclosing the seeds in a tough, adhesive envelope, is eagerly sought by the thrush, which can recognize it from a distance by means of the sign it throws out. The seeds hang by their sticky gum to the bird's bill after the fruit has been eaten, and the bird, to remove the nuisance, is obliged to rub its bill against the bark of the tree. This enables the seeds to plant themselves in the crevices of the bark, which afford just the soil they need to sprout and grow in.

Strawberries are a choice delicacy for the wood-hen, and their seeds are minute enough to escape being ground up among the millstones of its crop. The fowls, therefore, unknowingly sow the seeds in the forest along with their dung, and help the plant to find new beds in fresh soil. Geese are especially fond of the leaves of *Potentilla anserina*, and with them eat multitudes of the minute seeds of the plant. Thereby, while the natural home of the *potentilla* is by brooks, it is transplanted by the geese to quite different localities; and in mountain-regions, where nearly all the towns are on little streams, the *potentilla* is to be found as far away in the neighboring fields and along the borders of the woods as the geese are driven in the fall to feed upon the stubble.

When the Spaniards settled in Chili they brought with them their native apple and other fruit-trees. The fruits of these orchards, which were planted, of course, only in the neighborhood of dwellings, were fallen upon by the native parrots, and they carried the apples and undigested seeds into all parts of the country, so that the traveler may now find whole forests of wild apple-trees in places which have received no other touch of human cultivation. In a similar way crows have spread the opuntia over the uninhabited islands of the Canaries, and the nut-crackers in the Alps the seeds of the vetch in places where the winds and man could never have carried them.

Not a few birds are impelled, by the instinct to get their food in as much security as possible, to form relations with other animals. Starlings are found frequently associated with flocks of sheep, making themselves at home on their backs and playing the part of selfish benefactors of the suffering animals as they explore their wool for appetizing ticks and lice. So there are birds, according to eminent travelers, in Africa that perform similar service for elephants, camels, horses, the rhinoceros, and the hippopotamus. These prudent and vigilant birds are ever to be found in company with their huge providences, and give the sleeping monsters timely warning, with their shrill, familiar cries, of approaching danger. Lichtenstein relates that ostriches and zebras are on good terms with one another, to their mutual profit. The droppings of the zebra afford a breeding-ground for innumerable beetle-grubs, and these are a choice delicacy to the ostriches. When any danger approaches the company—if, for instance, a horseman appears in the distance—it is at once perceived by the tall, sharp-eyed birds, which take to flight in a direction away from the threatening object; and the dull-sighted zebras, without knowing what is really going on, sagaciously intrust themselves to the guidance of their careful associates. Similar harmonies in behavior may be observed among animals in very remote quarters of the world—between the rheas and the stags and guanacas of Brazil, and between the royal pheasant and the wild goat of the Caucasus. The ancients had a story of a bird —the trochilus—which made its living by picking the teeth of the

crocodile, and in return warned it against its enemies, which has been laughed at as fabulous; but, in the light of modern observations, there is nothing incredible in it.

Hunger sometimes causes birds to take to the most unaccustomed foods. When sparrows gather around fresh horse-dung and turn it over with evident relish, it is on account of the undecomposed oats it contains; but there are real coprophagists or dung-eaters among birds. Some vultures, according to Brehm, live chiefly on human excrement, and one of the handsomest gulls of the far North feeds largely on the droppings of seals and walruses.

There are aberrations of taste among birds as well as among men and other animals, the exact origin of which can be definitely traced out. Tame birds—geese, fowls, and doves, the last of which in particular are strict vegetarians—can, by the withdrawal of their accustomed grain, be won over to the enjoyment of animal diet till they prefer it, and may finally have their new taste so highly cultivated that they will spurn vegetable food. These changes do not mean much when they are compulsory; but they become very significant when they are wholly voluntary. Our common sparrow has within a few years gained legal, scientific, and even political fame by reason of its change of food-habit; and, amid all the controversy that has raged about its character, it is clear that it has become extremely ravenous and destructive to broods of young song-birds. Yet the sparrow is originally an eater of animal food, living on larvæ, worms, and snails, from which the step is not so very great to the devouring of a little wee, helpless chick; but the perversion of taste which the New Zealand kea (*Nester productus*) has undergone is of a different character. The nature of its home as well as its organization made it clearly a vegetable feeder, and there was no apparent occasion in its normal state for a bloodthirsty taste or a predatory inclination to arise within it. With the introduction of sheep-raising in New Zealand the bird's nature seems to have been changed. It learned to feast upon the blood of the slaughtered animals, and, having once tasted blood, it conceived such a relish for it that it was no longer able to satisfy its appetite with the occasional slaughter of a sheep, but began itself to take the initiative by falling upon animals which were suffering from slight wounds and opening the sores to make the blood flow. From this it advanced till it learned to help on the accident and make wounds for itself.

Birds living naturally on flesh are sometimes turned, without any stress of necessity, to become vegetarians. A considerable number of insect-feeders in Southern Europe eat fruits, especially figs, with evident relish, and the habit abides with them not only there, but also in other regions when they pass through them. I once became very indignant in Corfu at seeing an old, lank fellow, with a fowling-piece likewise old and lank, shooting the little singing-birds, among which

I recognized my particular favorite, with unerring aim. On my remonstrating with him, he said they were fig-peckers and destroyed the fruit. I laughed at him, and, to convince him that he was wrong, took out my pocket-knife and cut open one of the dead birds. It was his turn to laugh, for the maw of the bird was distended to the full with the soft, seedy fig-pulp! The green woodpecker, whose whole structure should make it a first-class insect-eater, is very fond of service-berries, and is, according to Pallas, destructive to the grapes around Astrakhan. Another woodpecker is fond of hazel nuts, and has learned how to crack them; but it may be that it was first introduced to this sort of food by exploring the nuts for worms. In fact, there is great room for the development of individual tastes in birds. But there are limitations in the matter, and the maxim "What is one man's meat is another's poison" applies well in this case. House-doves can eat beans without harm, but geese after partaking of them sicken and sometimes die. The cause of the difference is mechanical. The doves grind up the beans in their crop, while the geese have to digest them, and are sickened or killed by the swelling they undergo in the process. A real physiological puzzle is presented, however, in the case of some chemically acting poisons which a few animals, including some birds, can partake of with impunity, while they are deadly to all other creatures.

The birds' work is not always done when they have captured their food. Sometimes they have to prepare it to a certain extent. Many of the smaller birds of prey pluck their game before eating it. Others wash their meat, as I once saw a stork do; and while this queer bird would swallow frogs without any ceremony, it gave the mice that were thrown to it a thorough soaking, probably because their hairiness interfered with the comfortable swallowing of them. A sagacious canary-bird I once knew had learned the art of soaking in its drinking-vessel the crumbs that were too hard for its bill to break up. Shell-fish give birds much trouble, but the heron proves itself a match for them by swallowing them whole, shells and all, and keeping them in its maw till the animals are killed by the pressing in of the digestive fluids, and the shells open; then it spits them up and feasts upon the soft parts. Crows carry them up into the air and drop them upon stones, whereby the shells are broken up. The lammergeyer, according to Krüger's observations, does the same with marrow-bones and turtles; and it is possible that the eagle that killed Thales by dropping a tortoise upon him, mistook the shiny skull of the philosopher for a big, extra hard stone!

Storing up of food is quite a common practice in the bird-world. A European species of nut-hatch collects hazel-nuts when they are abundant, and hides them in the hollows of trees; and the snow-hen of Greenland does something of the same kind. The pine nut-cracker collects vetches, and the common nut-hatch, which appears frivolous

enough in its every-day life, acorns. One of the most remarkable instances of avian providence is that related by Saussure, of the Mexican *Colaptes*. The sides of the extinct crater of Pizarro, in Mexico, are covered during the winter months with the dried-up hollow stalks of the last year's agave-flowers, over which a yucca-tree here and there casts a scanty shadow. Hither, at the time of the ripening of the acorns, come large flocks of the birds with acorns, which they have brought from a great distance, for no oak-tree grows within many miles of the spot. Beginning at the bottom, they bore with their deft bills a succession of holes, at short distances apart, in the hollow agave-stems, and through them deposit their acorns in the interior cavity. The acorns look, when the magazine is filled, laid one after another, like the beads of a rosary. When the time of scarcity arrives, these insect-eating birds hasten to their store-houses, extract the acorns from them, fly with them to the yucca-trees, and, boring in the bark of them holes large enough to hold the acorn, as an egg-cup holds an egg, break open the fruit and eat it in comfort. Saussure avers that the acorns in question are sound, and free from worms.

Other birds, not looking so far into the future, provide only for temporary wants. A species of owl, according to Naumann, feeling the approach of a storm, lay up a stock of mice to last them through the nights when they will be unable to hunt. When the red-backed shrike has caught more than its appetite demands, it spits the surplus —young birds, frogs, and larvæ—on thorns; whence it has been called the thorn-turner, or, because the people believe that the number of its victims is always nine, the nine-killer. Curiously enough, a relative of this shrike, the *Collurio Smithii*, of Africa, employs, to accomplish a similar object, the more difficult method of slipping one end of a plant-fiber around the victim's neck, and hanging it by the other end to a bush, thereby giving its store-room a kind of resemblance to a gallows-yard. Not only are these lesser special peculiarities, these side-features of the bird's habits, as we might call them, determined by the kind of food and the method that has to be employed to obtain it, but more important and fundamental features of its life, its migrations, its distribution, and many of the motives of its propagation-history, can be traced back to them. The origin of the migratory instinct has usually been sought in climatic causes, and in the desire to avoid the cold and hardships of northern winters. This is an error. The little titmice and modest wrens, which are able to find the most carefully hidden larva in its winter-quarters, and can discover the most minute insect-egg, and which will not disdain a berry or a seed, stay with us through ice and snow; but the larger and stronger cuckoo remains in the north only while insect-life is at its height, and starts early on its southward journey. The great shrike is a permanent resident in Europe, going away only rarely, in case of dire extremity, but its three indigenous relatives are real birds of passage, ap-

pearing in May and leaving again in August. The former bird is large and strong enough to capture other grown birds and mice, and can thus always find a bounteous table spread for itself, while the others, confined by their more limited powers to smaller creatures, have to go away when, with the end of summer, these fail. The carrion-crow, to which everything that it is only possible to swallow furnishes a delicious feast, is not troubled by the severity of winter; but the rook, whose bill of fare is more limited, is in no condition to endure the scarcity of the winter months, and, therefore, on the approach of fall, it flies in large flocks over the Alps and Pyrenees, to the luxuriant fields of Southern Europe and Africa.

While this brief glance at the connection between the yearly migrations of birds and their food-supply must suffice for that point, the consideration of the distribution and accidental wanderings of these remarkable creatures, so far as it is related to their commissariat, demands more attention. It is evident that an animal species can live and thrive only when its accustomed provision, or some substitute similar in character to it, is present; where this is wanting, it can not gain a permanent footing; or it must adapt itself to its new relations, undergo gradual modifications in its habits and organization, and thus in the course of time become another and new variety. But wherever it can find its accustomed subsistence in the usual quantity and season, it will readily make itself at home without having to undergo any modification, unless it is provoked by other causes. If we ask what creatures—what birds, in the present case—have under particular circumstances the greatest chance for a wide distribution, the answer will be that they are those which, like the crow, the thrush, and the true shrike, are least particular in the choice of what they eat; and next, those whose appropriate food is most widely diffused. But the more closely a bird is adapted to particular kinds of food, and the more limited the circle of its distribution, the narrower will be the field of its residence. This is the case, not only with species, but in a wider sense with genera and families, and it is not to be overlooked that very widely distributed species are also frequently permanent residents. The most uniformly distributed animals under all conditions of climate and season are vertebrates, especially fishes and the smaller land-mammalia, and also some insects; and they also exhibit less important and diversified variations, and demand less on the part of their pursuers, than insects. Next to these are certain invertebrates of fresh and salt water; and among these the shore-species, particularly within their seasonal limits, display a great uniformity in all parts of the earth. Birds of prey, except the carrion-eaters, live on land-vertebrates. Three of their four families include quite or nearly cosmopolitan genera, and, what is rare among land-birds, only three species are wanting in very small districts. Fish and water animals constitute, with few exceptions, the food of the large groups known as the waders

and swimmers. Of the fourteen families of the former groups, four are quite and one nearly cosmopolitan; and of the eight families of the latter group, among which are some powerful fliers, only three have not a universal diffusion; and the two groups exhibit more genera occurring over nearly the whole earth (eighteen out of ninety-six and eleven out of seventy-nine) than all the other families of birds put together. But we can not overlook the fact that some of these genera stand on a very feeble footing.

It is interesting to observe that, in the other orders of birds, those kinds that live on fish are very widely spread. Thus, the kingfishers are cosmopolitan, and the genus *Ceryle*, which Brehm says includes "the strongest, most active, and most ravenous members of the family," is especially wide-spread, and is without representatives only in Australia, Madagascar, Europe, and Northern Asia. The nine not greatly differing species of water-ousel, whose habits are much like those of the true kingfishers, are very widely diffused wherever there are cool, clear, and rapid mountain-brooks.

The distribution is less wide of such birds as live principally on land-invertebrates, especially on articulates. Their occurrence is largely dependent, like that of plant-feeders, indirectly but intimately on the character of the vegetation; and those forms among them which, like titmice, wrens, and woodpeckers, live on insects at rest, as well as on eggs and pupæ, or on larvæ, either concealed or living in wood, and changing place but little, have the most extensive range; and, since larvæ pass the winter in one of the forms mentioned, they are permanent residents in temperate climates. In the measure that a bird pursues perfect insects, particularly those which fly, it becomes possible for it to be an established inhabitant only in warm climates. To dwell in colder regions, if it usually refuses vegetable food, it must be a good flier, and is then compelled to go away on the approach of the cold season and the accompanying disappearance of its food.

The presence of plant-eating birds is still more predominantly dependent on their food; and it is a matter of interest to observe how the opening out of the vegetation of a country reacts upon its ornithic population. Africa, wherever it is not wooded or desert, the Europeo-Asiatic steppes, and the prairies of America, are covered with grass and other mealy-seeded herbs, and are also the dwelling-places of hosts of weaver-birds, larks, and other grain-eaters, the flocks of whose numerous species are numbered by the thousand; and wherever they can find their food in winter, they abide. Groups of berry-bearing plants cover extensive regions of the north, and follow, as they stretch down toward the south, the cooler regions of the higher mountains; and in their suite we find everywhere, in the tundras of Siberia, on the slopes of the Himalayas, and in the Peruvian Andes, fruit-eating birds of similar genera. In the fruit-rich woods of the tropics, especially of South America, more than half of the native birds, though represent-

ing very different families, live chiefly, and for the most part exclusively, on the fruits; a thing that would not be possible in a temperate climate, where the development of the fruits is limited to a small part of the year. The immense northern pine-woods of the Old and New Worlds have their denizens from the bird-world living exclusively upon their seeds in the cross-bills, which are quite as much tree-birds as the tropical parrots.

The abundance of grains, fruits, insects, and even of mammalia, such as mice, is, on account of the varying local weather conditions on which they are dependent, much more variable in temperate than in tropical regions. One year may be rich in these products, and the next very poor; unusually favorable conditions for their growth may prevail for the time in one locality of an extensive territory, while in neighboring districts, from causes which it is often hard to explain, the contrary may be the case. Such circumstances must, of course, act with great effect upon the bird-world. At some times the birds of a region may, on account of the failure of their principal food and consequent famine, be driven from their hereditary quarters, and compelled, becoming wanderers, to resort to districts that are strange to them. When the pine-nuts fail in the north and on the mountains, the nut-crackers that feed upon them, obeying necessity, and not doing according to their custom, come south; and, when it is a bad year for birch-seed, multitudes of the northern linnets visit Europe. During long, snow-bound winters these northern and northeastern birds may be seen abundantly in Germany, and away down in Southwestern Europe, and the superstitious countrymen see in the unusual visitors the heralds of coming disasters.

On the other hand, an unusual abundance of food attracts birds into places to which they are not accustomed, and leads them into strange companies. Naumann relates that the thistles once got so firm a hold in the pasture-lands near his home that in many places the previously luxuriant grass wholly disappeared; then there came great flocks of green-finches, attracted by the abundance of their favorite food, and more in the next year at the time of the ripening of the seed, till, in a few years, all the thistles were exterminated through the agency of these birds. In another place he tells of a pine-woods of only thirty acres, to which hundreds of cuckoos resorted, attracted by the enormous number of caterpillars. It has also been frequently observed that horned owls are to be found by the thousand in localities that are plagued by an unusual visitation of mice.

Numerous birds attach themselves to droves of wandering animals. The passage-falcon travels regularly with the birds of passage; schools of herring are accompanied by throngs of fish-eaters, especially by the gannet, the presence of which is regarded by fishermen as the surest indication of the neighborhood of herring. So, swarms of locusts, pressing toward the West, are attended by birds to which they are

food, usually peculiar to the East; lemmings, by the snow-owl; and in former wars of great severity, the armies by wolves, hawks, and ravens; and I have been told by eye-witnesses that the relics of the Grand Army were pursued in their disastrous retreat from Russia by thousands of ravens. Many birds owe their specific diffusion to their seeking out men, the products of their civilization, or their domestic animals, to live upon them; and many formerly strange species no doubt find their way into new countries after the introduction of grain and fruit-raising.

The relation of subsistence to the propagation of birds is of the highest importance; upon it largely depend the time of breeding and the number of the eggs and of the brood. We are accustomed, without sufficient grounds, to assign the reason of our putting fowls to sit in the spring, as well as the migrations of birds, directly to climatic influences. We speak of the awakening of Nature, and it seems self-evident to us that the bird's nest with its tender chicks is a necessary part of it. Yet the time of year has hardly anything to do immediately with the propagation of birds, which is rather determined by the presence of a sufficiency of proper food.

In warm countries, such as Egypt, Ceylon, or Brazil, birds hardly observe a fixed period in their nesting, but each pair sets about the business whenever it finds itself in the most favorable conditions of subsistence, so that we can find nests and eggs of the same species in every month. The *Falco eleonoræ* of Southern Greece breeds at the unusual season (for a bird of prey) of August, and has its young in September. Quails are plentiful in the country at that season, having come down fat from the north, and in their multitude and helplessness fall a ready prey to the young falcons, and a much richer support than the birds can find in the spring, when, according to Erhardt's observations, no quails are ever taken in Greece. The *Bombicilia Carolinensis* of North America breeds as far north as 40° in June; it feeds its young on berries and cherries. The cross-bill never asks about the season or the temperature. It fixes its household indifferently in winter amid ice and snow, and in the height of summer, provided only sufficient nourishment for its children is present. The barn-owl likewise breeds irregularly. Its eggs and young have been found in October and November, but always in those years and places in which field-mice are unusually prevalent.

These few examples may suffice to show how, with birds, nearly everything turns upon subsistence; how the fact holds good not only for individuals and species, but that it is a matter of fundamental importance in their structure, their spread, and their habits, and how we may, with perfect right, apply to birds the maxim, "Tell me what you eat, and I will tell you who you are."—*Translated for the Popular Science Monthly from "Unsere Zeit."*

HIGHER EDUCATION OF WOMEN AND THE FAMILY.

By LUCY M. HALL, M. D.,

ASSOCIATE PROFESSOR OF PHYSIOLOGY AND HYGIENE AND PHYSICIAN TO VASSAR COLLEGE.

THE address of Dr. Withers Moore, President of the British Medical Association, delivered before a general meeting of that body, August 10, 1886, has attracted very wide attention. The importance of the subject with which the paper deals can not be overestimated. A few quotations will best show what it is and what are the views of the author upon it:

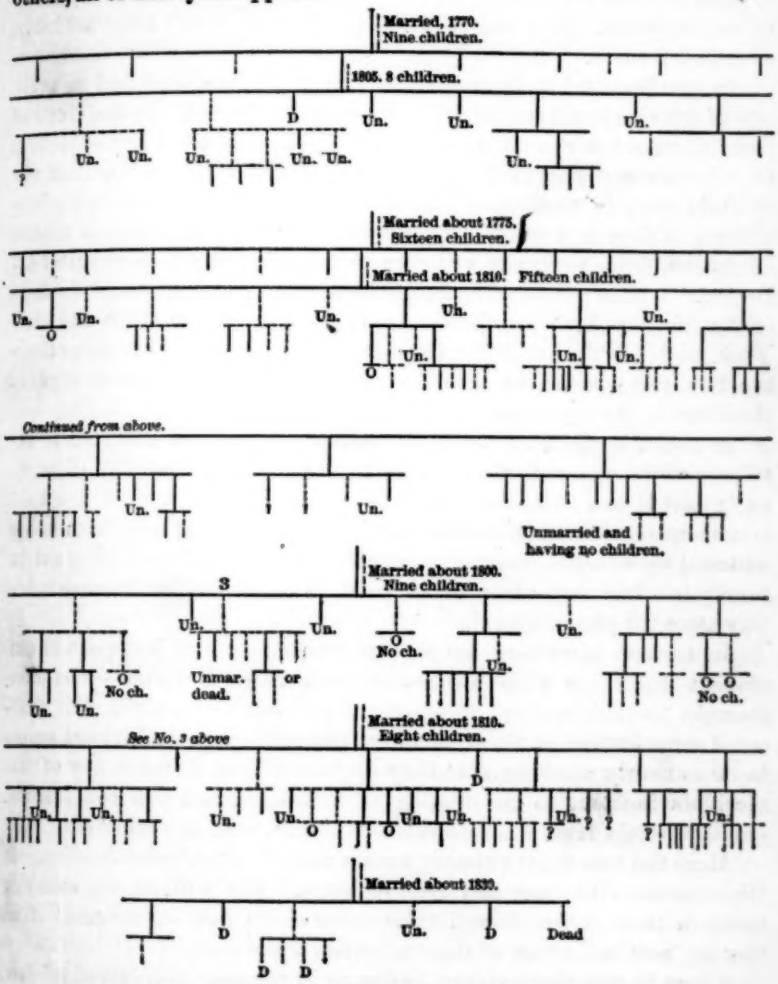
"Education is very expensive, physiologically as well as pecuniarily, and growing girls are not rich enough to bear the expense of *being trained for motherhood*" (the *italics* are my own), "and also that of being trained for competition with men in the severer exercises of the intellect. Woman should be protected from the rude battle of life by the work and labor of man. . . . It is not good for the human race that women should be freed from the restraints which law and custom have imposed upon them, and should receive an education intended to prepare them for the exercise of brain-power in competition with men. . . . Bacon, for want of a mother, will not be born. She who should have been his mother will, perhaps, be a distinguished collegian," etc.

The report goes on to say that "Dr. N. S. Davis, of Chicago, cordially sympathizes with these sentiments, and said that in America they had abundant evidence of their truth." And a late number of "Science" adds: "There are two channels of expenditure of physiological force in woman—the *terrible strain* of higher and professional education, . . . and the expense of being properly trained for motherhood."

Surely no one would be more ready than I to accept the conclusions of Dr. Moore and his supporters could I but be convinced that they have been drawn from reliable data, and presented in an unprejudiced manner.

It is true beyond question that in America the small and rapidly diminishing numbers in the family is a matter of grave national import. Dr. Nathan Allen has written much upon this subject, especially in connection with the New England States, but the difference in this regard between those States and other localities where the families are purely American is very slight. Presuming that physical laws operate much in the same manner upon both sides the Atlantic, we shall confine our discussion to American soil, and thus endeavor to find just what basis we have for accepting the theories which have been forced upon our notice, to discover in what the "abundant evidence" of Dr. Davis lies; or, failing in this, to seek for the kernel of truth in some other direction.

A short time ago I began collecting facts intending to show the great falling off in numbers in the American family, taken without regard to location or worldly circumstances. These I will now present (although they are as yet quite incomplete), because they have a direct bearing upon the subject which we are considering. In some of the tables only one or two lines of descendants could be traced; in others, all or nearly all appear:



Un., unmarried. Dotted line, females. Plain line, males. D, dead. No ch., no children.

Nearly all grades of American life have been included here, excepting perhaps that found in extreme poverty. The women were, for the most part, simply educated. Some in the district school only, while others were instructed with due deference to the limitations considered proper in female education, and with the usual surfeit of "accom-

plishments." A few were more highly educated, and yet as large a proportion of the latter as of the former have married, and the *largest families of the present generation belong to the most highly educated of the women.*

Within a stone's-throw of where I sit are half a dozen well-to-do American families. Taken together, there are not as many children in them as there are parents, and in none of them will there presumably be any increase. Not one of these mothers is in any sense a highly educated woman.

In one hundred and seventy-five American families I find an average of 3·2 children (now adults in most cases) to each. In one sixth of them there is but one child each. (No childless families are included.) Of the few really large families, the evidence seems to be that the mothers were in most cases well educated; in a few cases, exceptionally so. Taken as a whole, they represent a very wide range of female education, from the most ordinary to the highest which the time afforded. I have made many inquiries as to the proportion of children in American and foreign families in the schools of Brooklyn and New York, and I find that in the German, Irish, and Italian families there are two, three, and four times as many children, upon an average, as there are in the American family.

It would be difficult for even the most prejudiced observer to attribute these maternal deficiencies to the "higher education of women"; and it is a little singular that we are so often treated to a bald statement of the "higher-education" theory, without any facts being adduced by which to prove it. The diminishing and vanishing native family is a fact, but a fact which must be accounted for in some other way than the one proposed.

In turning elsewhere for an explanation, we will leave out of our present discussion those men—and their name is legion—who have brought to their wedded lives only the remnant of a vitiated or shattered constitution, or those in whom the instinct of fatherhood seems to be so nearly wanting, that they are not willing to make any of the sacrifices incident to the rearing of a family; and will consider the question solely from conditions which obtain with the other sex.

Here the two great primary causes are—1. Physical disability. 2. Disinclination to bear and rear children. We will briefly consider these in their order, though their order could well be reversed if in that lay any indication of their relative importance.

There is something almost ludicrous in the spectacle of a physician, educated and professedly observing, passing over without a word all the death-dealing follies which are making invalids of tens of thousands of women all about him, while he lifts his voice in dismal croaking over the awful prospect which looms before his jaundiced vision, of a time when more women shall be educated. Forgetting all else, he might have spared one thought for that doomed multitude, shut off

forever from honorable motherhood, gone to dire destruction, because untrained in anything which would insure to them a self-respecting independence.

Just what is meant by the term "being trained for motherhood," or why this training should be designated as "one of the two great channels of expenditure of physiological force," I find myself unable to understand. But it may safely be asserted that *any* training which exhausts without more than correspondingly strengthening a part, no matter where applied or for what purpose, should straightway be condemned. The "competition" and the "terrible strain" theories seem to me to have but little foundation. In my university life I saw nothing to confirm them. The work was pleasant and inspiring, and I am sure I can safely say that for the most part we enjoyed it. We did not trouble ourselves about the relative weight of our brains, and, as in the district school or the high-school, so here, it mattered little whether it was Jane or John who stood best; and it was quite as likely to be Jane as John.

As I recall the animated faces, the healthy bloom, and high spirits of the young women, I fail to find any ground for the assumption that their work was in any sense done at the expense of their vitality. On the contrary, I know that in many cases there was decided improvement in health from the beginning to the end of the course.

All this much-talked-of "physiological expenditure" is a myth. The intellect is quickened and strengthened by proper use, not at the expense of any other organ, but in and of itself. It is with this as with the muscles: strength comes with use. The fault has lain, not in the training of one set of organs, but in the neglect of others. The balance of health has thus been lost, and all parts have suffered in unison. To correct this, to establish a harmonious development of mind and body, is what true higher education aims to accomplish; and in doing this it is striking at the very root of woman's disabilities.

Seeing daily, as I do, young women in college in far better health than young women in society, or living in pampered idleness at home; seeing them healthier as seniors than they were as freshmen; knowing that my records tell me that they average a smaller number of excuses because of illness than do those of the men's colleges with which I am able to compare data, and knowing from statistical evidence that woman college graduates enjoy a sum total of twenty per cent better health than the average woman, how can I conclude otherwise than that college-work, *per se*, is not injurious to health, nor incompatible with the best good of the sex and the race? *

* President Bascom, of the University of Wisconsin, says on the same point: "The young women do not seem to deteriorate with us in health, but quite the opposite. . . . It has long seemed to me plain that a young woman who withdraws herself from society and gives herself judiciously to a college course is far better circumstanced in reference to health than the great majority of her sex.

Where is there a physician who does not know of countless numbers of women among the wealthier classes who are beset by all manner of ailments, for no other reason than because they have nothing to do, or rather because they have brought nothing into their lives which called forth the strong motive forces of their natures? The petty, selfish considerations which have dominated them have been too shallow to float them out into the broader channels, and they have become poor, stranded wrecks, with no interests but their aches and pains, no comfort but in the doctor's daily visit. The contemplation of these wasted lives, powers for good gone to rust and decay for lack of use, should make the angels weep. God forgive the man or woman who would wish to keep alive the baleful thrall of old prejudices and customs which work such irremediable evil to the human race! John Stuart Mill has said that "there is nothing after disease, indigence, and guilt so fatal to the pleasurable enjoyment of life as the want of a worthy outlet for the active faculties." He might have added that nothing so tends to promote disease and physical poverty as such a want.

Of the barbarous inflictions of fashion, of the effects of social dissipation upon the impressionable nervous system of a young girl, of the neglect of such exercise as is necessary to her vigorous health, I have no time to speak more fully, but among these are found some of the greatest hindrances to health, some of the most serious obstacles to motherhood.

One of the greatest of living physicians, Sir Spencer Wells, says: "As for the outcry against women taking up mens' work, it is breath wasted. For my own part, I think women capable of a great deal more than they have been accustomed to do in times past. If overwork sometimes leads to disease, it is morally more wholesome to work into it than to lounge into it, and if some medical practitioners have observed cases where mental overstrain has led to disease, I can not deny that I also have *at long intervals* seen some such cases. But for every such example I feel sure that I have seen at least twenty where evils equally to be deplored are caused in young women by want of mental occupation, by deficient exercise, too luxurious living, and too much amusement."

That a strong disinclination to bear children is manifested by many American women no one can deny, and the rich even more than the poor seem averse to giving themselves to the cares and deprivations incident to the rearing of a family. These women are ready and willing to marry, but they have no intention of burdening themselves with the laudable results of matrimony.

Women with one or two children, wealthy, living in palatial residences, will tell you that they can not *afford* to have more children; also that they are quite worn out with their present cares, and that to have a large family would *break them down completely;* so by their

manifold arts, all tending to thwart the Divine laws of their being, coupled with the selfishness and inanity of their lives, they succeed in bringing themselves to a state of physical disability which one of our prolific great-grandmothers would have been horrified to behold!

The root of the whole matter lies in the purposeless drift of everything which has been wont to enter into a woman's training. She has been made to feel that "woman should be protected from the rude battle of life by the work and labor of man," and these women have boiled down the sentiment into a selfish disregard of every obligation which they owe to the world. They most decidedly approve of all the limitations to "woman's sphere." They marry because they want to be taken care of, and their estimate of the value of life lies in the getting of the greatest amount of creature comfort with the least possible personal outlay; so "Bacon, for want of a mother, is not born." Not, however, because "the woman who should have been his mother is a distinguished collegian," but because she will have none of him; and his unwelcome existence is cut short long before it is time for him to appear upon this mundane sphere.

The poor woman has the same aversion to having a family that the rich one has, and for much the same reasons. Trouble and expense are to be avoided, and, worse than all, it is unfashionable to have a large family. I well remember hearing in my childhood a healthy young married woman held up to ridicule because she had so many children. Strange to say, her husband was commiserated in the same breath as a much-afflicted individual! At length, in an evil hour, the poor wife listened to an evil counselor, and the handsome, rosy-cheeked woman was from that time only a sallow, sad-eyed wreck of her former self. But she was no longer a target for the idle jests of her neighbors; the cradle was empty, and ever after remained so.

This is the kind of sentiment which openly or covertly prevails with us, and this is the Moloch to which are being sacrificed not only the health of so many of our women, but the lives of unborn millions who should stand crowned the sons and daughters of our glorious land.

It is in the higher, broader education of women that our hope for the future lies. The alarmists who cry that women will not marry if educated know full well that they are firing blank cartridges into empty space. There will always be plenty of women with brains and plenty also without brains from whom to choose, so that no man need go without a wife. If he prefers one who has a knowledge of Greek verbs stowed away somewhere in the neighborhood of an adorable pair of eyes, so much the better for him, for no amount of education will ever prevent a woman from marrying the man of her heart when he appears; and her education will be the best surety of her marriage resulting in all that which a true marriage should bring.

I do not mean to say that every girl should have a college education. What I do mean is, that the colleges are becoming centers for

the training of girls to more healthful ways of living, both mental and physical; and the only thing to do for women of the wealthier classes to lift them out of the ruts of idleness and destructive obedience to fashion's vagaries is to educate them, and give them broader interests and a mental grasp of the value of life because of its obligations to other lives.

Men and women must ever be one in every interest which affects the public good. It is difficult to see how even individual welfare can be made distinct. Women with low ideals, selfish, and untrained; women with feeble, undeveloped physiques, as well as women whose high moral and intellectual worth is enhanced by bodily perfections, all have an influence that puts its stamp upon the household of which each forms a part. And to "train a girl for motherhood" can be done in no better way than by building her from day to day upon the noblest plan which the grand and growing facilities of our time have made possible to us.

THE HABITS AND FAMILY HISTORY OF CENTENARIANS.

By Professor HUMPHRY, F. R. S.

THOUGH it must be granted even of the centenarian, as of all others, that he soon "passeth away and is gone," yet happily we are not obliged to admit that his "strength is but labor and sorrow." In many instances, on the contrary, he has, if not a green, yet a mellow and cheerful old age, one of happiness to himself and pleasure to others, brightened by a vivid though calm interest in the present, and unshadowed by apprehension of that which is to come. "Pay me a visit when you next come to Leamington," were usually among the words of adieu by Miss Hastings, at the age of one hundred and three, to her friends; "I shall like to see you, and hear how you are going on." There is a great moral in this; for while we are denizens in this Mammon, we are bound to make to ourselves friends of it, which is best done by a cheerful, happy use of it, and by enjoying it and using well the powers and privileges it gives us; and the injunction is none the less imperative and valuable when the sojourn in it has lasted for five score years and more. Moreover, in this, as in so many other instances, the influences are reciprocal; for associated as cheerfulness and happiness are with good doing and kind feeling, they are also much dependent upon the smooth working of the several parts of a sound bodily machinery, to the healthfulness of which they in their turn not a little contribute. So long, indeed, as the body is enjoyable, and its functions go glibly and smoothly on, the tenant is commonly desirous of continuing its occupation. When it ceases to be so, when lassitude and weariness

supervene, when means of communication with others are stopping, when the "*sans* everything" condition is impending, he is content to quit; and, when the tenement becomes distressing or painful, he is anxious to do so. Still, though the capacities for activity and work may be passing away, and life's "fretful fever" with them, the old person may comfort himself with the reflection that a useful mission still remains in the benign influence of a serene and benevolent disposition, which calmly estimates the things of time and sense at their true value, and which, leniently regarding the short-comings of others, gives the true crown of glory to the hoary head.

It is most satisfactory to find that the exercise—even the full exercise—of the various powers, mental and bodily, is not merely compatible with, but is conducive to, great age; that, as has been well said, "the harmonious development of the many-sided aspects of man is conducive to health and the prolongation of life," and that there need be no fear of entering heartily and actively, and with full interest and energy, into the assigned work of life, physical or mental. The body is made, not for ease and sloth, but for labor and play, for work and enjoyment, better still for enjoyment of work. Work, enjoyed as it should be, promotes health in body, and especially if stimulated by other motives than personal ambition and gain, engenders that cheerful, placid frame of mind which is one of the adjuncts of centenarianism.

France has lately celebrated the centenary of a philosopher and a chemist, M. Chevreul, who the same night occupied the President's box at the opera; and we are told that a Chinese centenarian recently passed the examination which qualified him to enter the highest academy of the Mandarins. Delightful was the account of Lady Smith, in whom a bright, intelligent mind and a brisk, healthy body had been in uninterrupted harmonious action for a hundred and three years, and who to the last took a lively interest in the world's political and other movements.*

* The original report of the committee of the British Medical Association, of which these observations by Professor Humphry are a part, was accompanied by a series of elaborate tables, in which all the details here summarized in the paper were given separately for each person. As the results and lessons of the investigation are clearly presented by Professor Humphry, in all their important bearings, with estimations of the value of each of them, we omit the tables, which, however useful they may be for reference, are not pleasant reading. In introducing the table the author remarks that in "their publication it is not meant to be implied that each of the fifty-two persons positively attained to the age of one hundred years. Some, no doubt, did so; and in eleven (two males and nine females) the age was confirmed by baptismal certificates or other records. Respecting others, there is necessarily more or less uncertainty; but these may reasonably be assumed to have reached nearly to that age. The name is given in each case; and the names are also given of the informants. These were nearly all medical men who volunteered the information which they would not have done unless they believed it to be correct, and who, in many cases, were well acquainted with the persons respecting whom they gave the particulars. The well-known pride of longevity and the tendency to ex-

Among the centenarians on our own list, the intellect is stated to have been high in eleven and low in five only; twenty are reported as strong, sixteen of average strength, and twelve only as feeble. Several were remarkable for mental and bodily activity and energy during their long lives. Many had been engaged in hardy bodily toil, or mental work, or successfully, in various occupations, and, in different ways, had played their parts effectually on the world's stage to the end of the long drama in better plight than the poet has represented them. I often wish Shakespeare had lived to give a brighter version of his seven stages, and to portray the old man not lean and slippered, but well favored and booted, keen in life's interests, and happy in promoting the welfare and enjoyment of others. Even in the bedridden state, of which the tables give seven examples (four males and three females), one of whom had been bedridden for seven years, all is not cheerless. The quiet coziness, the even temperature, the freedom from exposure, and the reservation to the vital organs of nerve-energy and nutritive material, consequent on the diminished use of the muscular system contribute to prolong the lives of some feeble persons who still retain the pleasures of intellectual occupation and social intercourse, to say nothing of the enjoyment of sleep and the gratification of the appetite; and it is curious, though not unfrequently to be observed, that persistence in bed actually increases both sleep and appetite. Some aged people lie in bed in the winter; and, in the dull routine of the workhouse, many old people drift into the bedridden state.

In our tables, as usual, in records of longevity, the women preponderate over the men (thirty-six to sixteen), in spite of the dangers incidental to child-bearing and the diseases associated with the varying demands made, at different periods, upon the organs connected with that process. This is obviously, in great measure, to be attributed to the comparative immunity of the woman from the exposures and risks to which man is subjected, as well as to her greater temperance in eating and drinking, and her greater freedom from the anxieties attendant upon the world's labor and business. Still, as I have said in a former essay ("British Medical Journal," May 9, 1885, page 928), there appears also to be a greater inherent vitality in the female, as evinced by the fact that, even in the first year of life, when the conditions and exposures of male and female infants are the same, the mortality of girls is less than that of boys. A somewhat larger number of boys are born, but they are more difficult to rear, so that the females

aggerate and deal with the marvelous, throw some suspicion over all records of this kind, and indeed had well-nigh caused a revulsion to misbelief in the capacity of the human body to retain vitality for so long a period as a hundred years. Abundant well-established examples of its doing so have, however, dissipated that skepticism which, I suppose, is now held by scarcely any one. It will be observed that none of the cases here tabled range among the marvelous and startling instances we sometimes read of; not one is stated to have reached one hundred and ten; one only is said to have been one hundred and eight and one one hundred and six.

soon take the numerical lead, and they maintain it with almost steadily increasing ratio to the end. It is also to be learned from the analysis of the tables that the elasticity of the thorax, as evinced by the condition of the costal cartilages, and its capacity for dilatation during inspiration, is better preserved in women than in men. In the matter of the arcus senilis, also, the woman has the advantage; but in the condition of the arterial system, much difference is not shown.

Of the 36 women, 26 had been married, and 11 had large families; and it may be some consolation to young mothers and their friends to find that 8 of the 26 married before they were twenty—1 at sixteen and 2 at seventeen. The dangers, happily diminishing, which are incidental to child-bearing, must not be forgotten; but, irrespective of these, the process itself and the attendants thereon do not seem to militate against longevity. Indeed, the capacity for the full exercise of this, like that of the other normal functions, is one of the qualities in those who have the other requisites for attaining to great age. One only of the married women was childless; but neither the age at which she was married nor the duration of her married life are given.

It might be anticipated, indeed, from the matrimonial tendency, and the prolific quality evinced by the tables, the average number of children born to each, whether male or female, being 6, that there would be, through inheritance, a gradual increase in the centenarian breed; and it is probable that this is the case, and that the duration of life is, from this and other favoring causes, gradually being extended. The life-period of the children we have no means of determining with accuracy, the returns being, from various causes, imperfect; but we may safely accredit them with, at least, an average longevity. It is, moreover, a point of some interest that many of the centenarians were members of large families, averaging, indeed, 7 or 8; those designated as "only children" being limited to 2. Of the 52, 41 had been married, and 11, of whom 10 were women, had remained single; but we can not from this draw any inference as to influence of matrimony upon longevity. Possibly something may be gleaned from the analysis of the numerous reports I have received of persons between eighty and one hundred.

The fact that 12 of the centenarians were "first children" does not accord with the idea entertained by some persons that first children are at a physical disadvantage. The generally prevalent custom of inheritance by the first-born, and the Mosaic injunction (Exodus xii, 2), "Sanctify unto me all the first-born; whatsoever opened the womb among the children of Israel, both of man and of beast, it is mine," are also scarcely in harmony with such a view. Nevertheless, some confirmation of the view is furnished by the feeling on this matter, founded, it may be presumed, on experience in racing-stables, which, I have been informed, is not in favor of firstlings. In the case of one of our centenarians, the parents were first cousins.

The tables and the analyses of present and past condition yield nothing striking or even novel or unexpected, or in that respect interesting; but they are not therefore less valuable or important. The average centenarian qualities are precisely those which might have been anticipated: a good family history; a well-made frame of average stature (5 feet 8 inches, which is rather above the average, in the male, 5 feet 3 inches in the female); spare rather than stout, robust, with good health, little troubled with ailments of any kind, with good digestion, regular daily action of bowels; active, capable of much exertion, with the restorative advantages of good, sound sleep permitting or inducing early rising; good vocal organs; a good appetite moderately indulged, with little need of, and little consumption of, alcohol or animal food; an energetic yet placid temperament; a good intelligence; the hair holding its ground and its color well; the organs of sight and hearing performing their functions well and long. Our centenarians afford, in short, good examples through life of the *mens sana in corpora sano;* and in by far the greater number there was a total absence of any evidence of rheumatic or gouty affection, past or present, in the joints of the hands and fingers—a condition which is not unfrequently regarded as one of the heralds of old age, and which, doubtless, like many other local maladies of which it may be taken as a sample, is often prophylactic against other more serious maladies. It seems that the frame which is destined for great age needs no such prophylactics, and engenders none of the peccant humors for which the finger-joints may find a vent. To have a vent for such humors may be good, but it is less good than to be without them. Of the eight in whom those joints were stiff or deformed, it may be observed that one, a man, always "drank as much as I could, and always will do"; a second and third, poor women, had been subject to much exposure, and had a rough life, following the army in various parts of the world; of the case of the fourth, also a female, in whom these joints were stiff, we have no account of the habits. The fifth, a female, appears to have been a temperate person in comfortable circumstances, in whom no particular reason for the deformity of the joints can be assigned; and the same may be said of the sixth and seventh, except that the latter was in the habit of partaking rather freely of animal food, and also probably of the eighth, though we have not much information as to her past habits. It is rather remarkable that all of these, except the first, are females; of these females, three were poor, and the others in comfortable or in affluent circumstances.

Teeth.—The loss of teeth presents some interesting problems. It seems to be an associate of civilization, partly because the varied and peculiar conditions of civilized life tend to induce it, and partly because those conditions have the effect of preserving the body beyond the limits, which, under natural or uncivilized conditions, appear to have been assigned to it. Twenty-four of our centenarians had no

teeth, some had been without them many years, and the average number retained was only four or five, which, in many instances, we may conclude to have been of little value. The artificial substitutes were used in so few instances, that we can not from them form an estimate of the aid afforded by these appliances in the prolongation of life; but that they do contribute to the maintenance of health and the prolongation of life can scarcely be a matter of doubt. The teeth had disappeared, as we have before found to be the case ("British Medical Journal," May 9, 1885, page 929) in the upper jaw more than in the lower; but the tables do not show so much difference between the men and the women as I then marked.

It is somewhat remarkable that, though as many as twenty-eight used glasses, thirty-five, including many who used glasses, are reported to have been in the enjoyment of good sight. The occurrence of presbyopia does not seem to be associated with, or to be a prelude to, inconvenience or impairment of sight beyond that which may be corrected by glasses. These had been used by some for forty or fifty years; and in three it appears that the defect was spontaneously rectified, and that as they grew older they became able to dispense with glasses.

That the majority of centenarians are content, as we find them to be, with three meals in the day, and are moderate or small eaters, partaking of little animal food and little alcohol, is in harmony with the lowered activity of the muscular and other organs, and the consequent lowered demand upon the nutritive processes and the nutritive supply. That nevertheless the rate of the pulse, averaging 70, and that of the respiration, averaging 22, is maintained, may be accounted for by the diminished elasticity of the circulatory and respiratory apparatus. The arteries become less capable of accelerating the blood-stream, and the vital capacity of the chest is much reduced, as shown by the slight difference in the chest-girth between the state of inspiration and that of expiration.

The sleep-duration, averaging nearly nine hours, indicates also a slowness, a feebleness, of the restorative processes. Repair is tardily and with difficulty striving to keep pace with wear. We know that it is one element in the developmental law of growth and decay, that it should not quite do so in the aged frame. Up to adolescence repair has the mastery, and the body gains in weight and strength; in middle age, repair is about equal to wear; but in later life its gradual failure, attended with diminishing weight and strength, conducts the body slowly along its normal course to dissolution. Long, good sleep, does something to put a drag on the downward course, and is a great sustainer of the aged frame. Much difference in sleep-duration is noted in the tables. In some, sleep is said to have been short and indifferent, or bad, perhaps owing to peculiar disturbing causes; but in 32 out of 44 it is said to have been good.

The maladies of these old people range themselves chiefly under

the head of weakness, evinced by inability to put forth or maintain much effort of any kind, bodily or mental. Fatigue soon comes on; the muscular weakness proceeding to partial or complete loss of the use of the lower limbs, and to tremor of the upper limbs. The difficulty of penning a straight line resulting from this latter, being the cause of the smallness of the handwriting, often noticeable of old people. The weakness of the brain evinces itself in impairment of memory; in slowness of apprehension; in inability to fix the thoughts long on one thing; and the tendency, therefore, to wander from one subject to another, and to travel to and fro, which may pass on to want of control, or imbecility, or even to dementia. This last, saddest state of all, was witnessed only in two of our centenarians. Indeed, the brain in many held out as well as or better than other organs—which may be regarded one of the bright rays, if not the brightest, in the centenarian landscape.

The weakness, or failing, seems to have been about equal in the several great organs, showing that these organs presented to the last that good balance of enduring strength which is so essential to longevity. The lungs are, through life, the most sensitive to atmospheric changes, as well as to alterations in the conditions of the blood. Hence, bronchitic and pneumonic affections are a common source of distress, and a frequent cause of death at all periods of life; but it does not clearly appear that the very aged are more liable to them than those less advanced in years.

In the majority in our table, the action of the heart was regular, the pulse small and compressible, and evidences of arterial degeneration not manifest. In some of those who were auscultated, more or less *bruit* was heard, indicating some valvular or arterial roughness; but it made no apparent impression, and the individuals were unconscious of any defect. The slowness of micturition, mentioned in two men, and the incontinence in three females, as well as the frequency of micturition in three, may also be regarded as resulting from atony, rather than from disease. Indeed, these old people had outlived the period which is most liable to prostatic and other urinary troubles. Other minor maladies and discomforts, of which we may conclude that centenarians have their share, have, in many instances, probably been thought not worthy of mention.

Though the majority had suffered little from illness at former periods, some up to the very end of their long life, yet it is not unsatisfactory to find that the effects of illnesses, even when severe, do not always preclude longevity. One had rheumatic fever when young, and rheumatism afterward; one had epilepsy from seventeen to seventy; one had renal disease, with loss of sight, at thirty, from which there was complete recovery; one had an abscess connected with the spine, a stiff knee from injury at fifty, and diarrhœa from seventy-five to eighty, besides fevers and other ailments; one had gall-stones at

sixty; one was ten years in an asylum after a confinement; one had peritonitis; one had had fever at twenty-five, also jaundice and small-pox; one had "bad-stroke" at sixty, for which she was bled, and two less severe strokes at seventy; one had renal dropsy at eighty-two, lasting for two years; one had acute bronchitis at ninety-five; one had paralysis at ninety; one had severe herdes zoster; one had rheumatic fever at seventy; one had severe bronchitis at eighty-two; one had paralysis at seven; four had fever—two of them badly.

The recoveries from illness at great age are to be noted. We find that one case recovered at eighty-two from renal dropsy, which lasted two years, and at ninety-eight recovered from a large slough on the thigh, caused by a bruise; another from acute bronchitis at ninety-five, and pneumonia and erysipelas of the head at ninety-nine; a third from rheumatic fever at seventy; another from severe bronchitis at eighty-two; and one from severe fever at eighty-four; six had suffered injury to the hip after the age of ninety; one broke the neck of the thigh-bone at ninety; and one at one hundred and one, the latter so far recovering as to go on crutches.

Most interesting and important of all are the life-habits of these old people, among which activity, out-of-door exercise, and early rising, with moderation in diet and alcohol, stand out in strong relief, and are evidently among the important factors in longevity. At the same time, we perceive that most of them may be regarded as the attributes of the well-wearing body, that is to say, they are the resultants of health, as well as the promoters of it. The healthy, vigorous body can scarcely be otherwise than active in one way or other; and few things tend to promote health and vigor more than activity—activity without excitement—an activity which is not forced beyond the measure of good and easy repair—an activity which does not wear the body out. The candle ought to burn briskly, and, as a general rule, at both ends, regarding the head or brain as one, and the limbs or locomotory agents as the other; but it should not burn too fast; and it may be that, in some persons, an extra rate at one end is better to be compensated by a lower rate at the other. Some persons, at least, seem to find that severe and continued brain-work is incompatible with much leg-work. Into this question, however, I will not enter.

Upon out-of-door activity, with the refreshing influence of open air, stress should be laid, for it must not be supposed that exercises and athletics indoors, where they are much more exhausting, are a sufficient substitute, especially in the case of young and growing persons.

Such activity causes a brisk trade in the nutritive market; and the demand is pretty sure to be met by the supply, when food can be obtained. The moderation or spareness in diet, notably in the past habits of our centenarians, limiting the supply, prevents a wasteful overflooding of the market, and compels an economical and good employment

of all that is brought there. Surplusage can do but harm. The body associates itself with a certain well-known evil agent in finding for idle food "some mischief still to do," although, in some individuals, a drainage for unused material may be made through the intestinal or renal or cutaneous organs, which, be it remembered, were never meant to serve that purpose, and which are likely to suffer from the strain thus put upon them. In many a more deleterious vent is found in gout, bilious attacks, etc., which, at the same time, cause a temporary arrest of supply, or in graver inflammatory attacks, or the still graver malignant affections. The temperance in all things of our centenarians has, without doubt, been one great means of keeping order in their nutritive system, and preventing aberrations into morbid processes. Few more mischievous notions have found their way into common acceptance than the idea that strength is proportionate to the amount of food taken; and it is accepted and mischievous, no doubt, in a greater degree than it would otherwise be, because it rests upon the basis of truth that strength can not be maintained without a sufficient supply of food.

The total abstainers will not fail to observe that twelve of our centenarians had been through life, or for a long period, in their ranks; that twenty took little alcohol; that this was, in the case of some of them, *very* little; and that eight were moderate. No. 8, it is true, often drank to excess on festive occasions; No. 14 was a free beer-drinker; and No. 35 "drank like a fish during his whole life," which probably means when he could, for it is added that "he could not usually get much." The exceptions, therefore, show little against the rule. It is, perhaps, scarcely less important to note that our centenarians were, for the most part, small meat-eaters.

The early rising was in many of the instances necessitated by their occupations. Still, this habit must be regarded as an associate or sequence of the healthful activity just mentioned, and of an activity pervading the reparative work which has to be done in sleep—an activity which quickly and thoroughly refits the body for its next day's work, and gives the energy, the willingness, the desire to resume it. Sleep should come quickly, be intense while it lasts, and cease quickly and completely; quite awake or quite asleep; no hovering between the two; no need of, or desire for, a little more slumber, a little more sleep. "When one turns in bed, it is time to turn out," whether rightly or wrongly attributed to the Duke of Wellington, is a saying worthy of him, and accords with the energy that contributed to make his life great as well as long.

While we thus gain more clear knowledge of the qualities for, and the adjuncts to, centenarianism, an examination of the table shows that there is no royal road to it. We see that it is attained under a variety of conditions, and that few persons can be said to be excluded from the prospect of it. With regard to certain of the important

requisites, we can not alter our position. No one can make his family history better than it is, or make his body to be wound up for a longer period than its normal life's span; but it is the duty of each to endeavor to make it cover that span, and to go as long as its appointed time. The uncertainty as to that term, as it is one of the greatest blessings of life, so should it be one stimulus to us to ascertain and to follow the means most suited for prolonging life, especially as we find the result of our investigations to be that those are the means best calculated to turn it to good account and to make it happy.

Analysis of the Table of Centenarians.

By A. Francis, M. R. C. S., of King's College, Cambridge.

PRESENT CONDITION.

Age.—Fifty-two returns; average age, about 102½ years. *Males.*—Sixteen returns; average age, about 102¼ years; respective ages, 108, 105, 104, 3 aged 103, 4 aged 102, 2 aged 101, 101½, 3 aged 100. *Females.*—Thirty-six returns; average age, about 102⅛ years; respective ages, 2 aged 108, 106, 3 aged 105, 3 aged 104, 4 aged 103, 102½, 3 aged 102, 7 aged 101, 100¾, 100½, 10 aged 100. In 11 cases, the age returned was verified by baptismal certificates or other records; of these, 2 were males, aged 101 and 100; and 9 were females, aged 108, 106, 104, 103, 102, 101, 101, 100½, and 100.

Male or Female.—Fifty-two returns; M. 16, F. 36.

Single: Married: Widowed.—Fifty-two returns; S. 11 (of these 10 were females), M. 5, W. 36.

Affluent: Comfortable: Poor.—Fifty returns; A. 3, C. 28, P. 19.

Fat: Spare: Average.—Fifty returns; F. 9 (of these 8 were females), S. 23, A. 18.

Full-blooded: Pale: Average.—Forty-six returns; F. 8, P. 14, A. 24.

Strong: Feeble: Average.—Forty-eight returns; S. 20, F. 12, A. 16.

Figure: Erect or Bent.—Fifty returns; E. 25, B. 25.

Height. *Males.*—Twelve returns; average, about 5 ft. 8½ in.; one also returned as short. *Females.*—Twenty-six returns; average about 5 ft. 3 in.

Weight. *Males.*—Seven returns; average nearly 138 lbs. *Females.*—Ten returns; average about 129 lbs. Respective Weights: *Males.*—182, 165, 147, 140, 120, 112, 98 lbs. *Females.*—196, 154, 140, 136, 126, 126, 120, 112, 112, 70 lbs.

Voice.—Forty-seven returns; loud, 6; clear, 16; weak, 7; full, 3; loud and clear, 8; full and clear, 6; loud and full, 1.

Hearing.—Forty-nine returns; good, 22; indifferent, 17; bad, 9; deaf, 1.

Joints.—Forty-seven returns; natural, 37; stiff, 4; deformed, 3;

stiff and deformed, 1; the last was stiff from chronic rheumatism, and deformed from contraction of palmar fascia; slightly deformed, 2; one of these was "from rheumatoid arthritis."

SIGHT.—Fifty-one returns; of these, 34 had good sight; 6 had cataracts, in one case unilateral, in another commencing; in 8 others, failure of eyesight was reported, apparently independent of presbyopia.

GLASSES.—Thirty-five returns; 28 used glasses, 7 did not, but of these 4 were returned as "poor," and were possibly unable to read; 6 had used them for 40 to 50 years, 5 for 30 to 35 years, 4 for 10 to 20 years, 2 for 4 to 6 years, 5 for "many years," 2 for "few years." One had used spectacles for many years, but for last twelve years had been able to read without them; another had not used them for twelve years; another "not for many years," but one "can not now get them strong enough."

DIGESTION.—Forty-seven returns; good, 40; moderate, 7.

APPETITE.—Forty-eight returns; good, 36; bad, 2; moderate, 10.

EATER.—Forty-six returns; moderate, 25; small, 9; large, 12.

NUMBER OF MEALS DAILY.—Forty-three returns; average number rather more than 3 daily; the greatest number was 5 daily (in 1 case); the least number was 2 daily (in 5 cases).

ALCOHOL.—Forty-six returns; none, 15; little, 24; moderate, 6; great deal of beer, 1.

ANIMAL FOOD.—Forty-one returns; none, 3; moderate, 10; little, 25; very little, 2; much, 1.

BOWELS.—Forty-three returns; daily, 26; alternately, 6; irregularly, 11.

APERIENTS.—Forty-one returns; rarely, 22; never, 14; frequently, 5.

DISPOSITION.—Forty-six returns; placid, 14; irritable, 8; energetic, 11; placid and energetic, 8; irritable and energetic, 5.

INTELLECT.—Forty-six returns; average, 29; low, 5; high, 11; childish for six years, 1. One was said to be "slow in comprehending questions, but smart in reply."

MEMORY. Recent Events.—Thirty-nine returns; good, 26; bad, 6; moderate, 7. Past Events.—Forty-seven returns; good, 39; bad, 4; moderate, 4. One "remembers and will quote a great deal of the Bible," another could "repeat about 100 Psalms correctly."

HABITS.—Forty-eight returns; active, 26; sedentary, 15; bedridden, 7; of these, 4 were males and 3 females; one, a male, had been bedridden for one year, and one, a female, for seven years.

OUT-OF-DOOR EXERCISE.—Forty-five returns; bedridden, 7; none, 16; of these, one "can walk very well," another "stays in bed in cold weather;" little, 9; one of these "mended the thatch of her cottage at 96, and was always the first home from church, being a rapid walker"; moderate, 1, she "goes to church twice on Sundays"; eight walk out; of these, one "walked four miles yesterday," another "walks

daily half a mile, can walk three miles," another is "fond of sawing firewood;" two still work, one of these "attended Hexham market, two years ago"; one "worked in a field at 102"; one was "much out."

SMOKES.—Forty-five returns; much, 7; four of these were women; little, 2; one was a woman; moderate, 3; one was a woman; none, 32; chews, 1.

SNUFF.—Forty returns; none, 37; much, 1; this a woman who also smoked a little; little, 2, one being a woman, who did not smoke, the other a man, who smoked a little.

SLEEP.—Forty-four returns; good, 32; bad, 5; moderate, 7; *Number of Hours.*—Twenty-nine returns; average rather more than 8½ hours; 3 slept 12 hours; 8 slept 10 hours; 1 slept 4 hours; and 2 slept 6 hours.

HOUR OF GOING TO BED.—Thirty-five returns; average, about 9 o'clock, one retired at 12 o'clock, one at 11, and 5 at 7 o'clock; 7 were bedridden.

HOUR OF RISING.—Thirty-five returns; average, about 8 o'clock; six rose at 6 o'clock, one at 5 o'clock, nine at 10 o'clock, one at 11 o'clock, and one at 4 P. M.

CHEST-GIRTH IN INSPIRATION. *Male.*—Six returns; average, 36¼ inches. *Female.*—Nine returns; average, nearly 31 inches. Male and female together, average about 33 inches.

CHEST-GIRTH IN EXPIRATION. *Male.*—Five returns; average, about 36½ inches. *Female.*—Seven returns; average, nearly 30 inches. Male and female together, about 32½ inches.

ELASTICITY OF RIB-CARTILAGES. *Male.*—Six returns; distinct, 1; indistinct, 5. *Female.*—Thirteen returns; distinct, 5; indistinct, 8.

PULSE.—Twenty-nine returns; average, 74·75 per minute. In some cases, disease of the heart or lungs was returned, and in others the pulse-rate was unusually high, and the condition of the heart and lungs was not detailed; excluding these cases, eleven in number, the average becomes 69·70 per minute. *Regular, Irregular, Intermittent.*—Twenty-eight returns; R. 24; Irr. 1; Int. 3. *Large, Small, Moderate.*—Twenty-seven returns; L. 9; S, 17; M. 1. *Compressible, Incompressible.*—Twenty-eight returns; C. 24: I. 4.

ARTERIES. *Male.*—Nine returns; even, 4; knotty, 2; tortuous and knotty, 1; tortuous, visible, and even, 2. *Female.*—Twenty returns; even, 8; tortuous, visible, and knotty, 3; visible and tortuous: 2; tortuous, visible, and even, 1; visible and even, 2; tortuous and knotty, 1; tortuous, 2; tortuous and even, 1.

ARCUS SENILIS. *Male.*—Seven returns; much, 4; little, 1; absent, 2. *Female.*—Nineteen returns; much, 5; little, 8; absent, 6.

RESPIRATION.—Twenty-four returns; average, 24 per minute. Excluding those cases, eleven in number, in which heart or lung disease was returned, or in which the rate of respiration was high, and the condition of the heart and lungs was not mentioned, the average be-

comes 21 to 22 per minute. *Regular and Irregular.*—Twenty-four returns; regular, 21; irregular, 3.

TEETH.—Forty-two returns; 24 had none, and in 13 the teeth were specified. Among the 37 cases, there were 144 teeth: Upper jaw, 63—incisors, 19; canines, 8; molars, 36. Lower jaw, 81—incisors, 23; canines, 13; molars, 45. In five cases the number was alone given. Average (42 cases) 4–5 teeth. In one case, they "all came out whole." *Males.*—Fourteen returns; 6 had none; average, 4 teeth. *Females.*—Twenty-eight returns; 18 had none; average, nearly 5 teeth. Three females had a complete set, and another had 17 teeth; one male had 24, and another 16, teeth.

ARTIFICIAL TEETH.—Thirty-eight returns; none, 34; yes, 1 (female); many years, 2 (male and female); from 50 to 90, 1 (female).

EVIDENCES OF FAILURE.—Thirty-five returns; none, 18; failures in 17 cases. *Heart*, 2.—In one, "sounds distinct, no murmur, very irregular, at one minute beating 60 to 70, and at another double as fast"; in the other, "circulation feeble, frequently sick and faint, as if she were going." *Heart and Lungs*, 3.—In one, "heart and lung sounds weak"; in another, "pulse intermits 6 times in a minute, impulse weak, slight bronchitis"; in another, "aortic regurgitation, slight bronchitis." *Heart and Urinary Organs*, 3.—In one, "loud systolic *bruit* at base, no appreciable interference with circulation, micturition frequent"; in another, "heart-sounds tumultuous and irregular, micturition frequent"; in another, "heart's action slightly irregular, not discernible in pulse, frequent micturition." *Lungs*, 2.—in one, "chronic bronchits"; in the other, "cough for four months." *Brain*, 3.—Senile dementia in two cases; in one, "childish for six years"; in the third case, apoplexy, right hemiplegia, aphasia, and death shortly after. *Brain and Urinary*, 1.—"Aphasia for 14 days, incontinence of urine." *Urinary*, 4. One had "some incontinence for ten years"; in two others, micturition was slow; and in another, "incontinence."

MICTURITION. *Male.*—Ten returns; natural, 7: slow, 2; frequent, 1. *Female.*—Twenty-three returns; natural, 18; frequent, 2; incontinence, 3—in one case for 10 years.—*British Medical Journal.*

Lamarck's Herbarium.—The botanical department in the Museum of Paris has just added to its collection the herbarium of Lamarck. On Lamarck's death this work passed into the hands of Mr. Roeper, Professor of Botany in the University of Rostock, who incorporated it with his own. On his death, in March, 1885, it was acquired by the Government of Mecklenburg-Schwerin for the University of Rostock. Professor Roeper's successor afterward offered it to the Paris Museum. The herbarium is contained in twenty-one voluminous cases, and comprises 10,000 species in perfect preservation, accompanied by labels and manuscript descriptions, and designs from the hands of the author.

HOW A NATURALIST IS TRAINED.

By J. S. KINGSLEY, Sc. D.

EVERY trade, every profession, has its own peculiar methods of procedure, which, while not kept secret, are still unknown to the general public. This ignorance is due to several causes, among which may be mentioned a lack of interest and a lack of any simple account of the processes involved. If one not educated to the legal profession be told the facts in a certain case, and then be turned loose in a large law library, how long would it take him to work up a brief? How would he know what books to consult, where to find decisions bearing on the cases in question, or, when found, how to interpret them, and ascertain their exact relations to the subject in dispute?

There is probably just as much mystery surrounding the way in which the naturalist investigates the secrets of Nature, yet the true student has not the slightest desire to conceal his methods; but, on the other hand, is perfectly willing, even glad, to tell how he arrived at his results to any one who wishes to hear. The student, on first entering a biological laboratory, thinks he has an easy task before him. All that he has to do in order to become a naturalist is to see and to remember what he sees. In a few days this confidence gives way to a spirit of despair. He begins to realize that observation is not so easy as he thought, and that the structures so distinctly shown in anatomical plates are not so readily discovered in the object before him. He becomes satisfied that in science, as in the other departments of knowledge, there is no royal road to learning. Gradually he acquires the methods, and knowing them his knowledge increases. What at first seemed an impossible task is seen to be really easy, and things at first invisible are soon as plain as day. At first sight it would seem difficult to take an egg, only $\frac{1}{100}$ of an inch in diameter, and cut it into slices in any desired manner, and yet it is an every-day operation to section such an egg and convert it into fifty slices.

It is the purpose of this article to tell in general terms the way in which a naturalist, and especially a zoölogist, arrives at his results. To give exact details would expand this article to a large volume and render it extremely abstruse and technical, while a mere outline will be much shorter and (the writer hopes) more interesting. Within the past few years the methods of study and tendencies of biological thought have undergone an immense development; and although each of the nearly four hundred colleges and universities in the United States pretend to give instruction in botany and zoölogy, there are really less than a dozen where the student can obtain a good and solid foundation in the biological sciences as they exist to-day.

Until school-life begins, a child is a good observer, but the whole

training after that period is one adapted, if not intended to repress the forms of observation, and hence the first thing to be taught a student on entering the biological laboratory in one of the institutions of the better class is how to observe. This, though it appears an easy task, is really one of considerable difficulty. First, there is a tendency to consult books so as to learn what is or should be seen; and, secondly, there is a sudden jumping at conclusions from the most superficial examination of the specimen, and these conclusions are adhered to most tenaciously, utterly preventing the formation of any different view.

Together with the formation of habits of observation, it is desirable that a certain amount of facts be obtained, and so the student is set at the dissection of a selected series of animal types; for instance, the sea-anemone, sea-urchin, earth-worm, lobster, clam, and frog. Economy of material is insisted upon, and the admonition is frequently given that each stroke of the scalpel should mean something. Drawing is extremely essential, for, if the student be made to draw exactly what he sees, he will have to look more closely, and, at the same time, the instructor can readily see exactly how well his pupil works, and exactly where his difficulties lie. At first the student declares he can not draw, that he has not the slightest taste for art, and yet, after a very little experience, he makes thoroughly intelligible, if not artistic, representations of what he sees.

A very important point in making these small dissections is making them under water. If one attempt to dissect a clam in the open air, the various parts will settle down and adhere to each other; while, if the operation be performed under water, this difficulty will be avoided, the parts being buoyed up by the surrounding medium. To trace the course of the blood-vessels, injections are resorted to. Some quickly hardening mass, like plaster-of-Paris or melted wax, or gelatine colored by carmine, vermilion, or Prussian blue, is forced into the arteries or veins, and then the student, by following the streaks of color, can readily follow the course of the circulation. When sufficient skill is obtained by dissection of these larger forms, smaller ones may be taken, and after a short time the student experiences but little more difficulty in dissecting a grasshopper or a snail than in a pigeon or turtle.

Besides obtaining a skill in dissection and a capacity for observation, a student is led in this anatomical course to make comparisons between the various objects dissected. This results in a recognition of similarities and differences, and exercises the reasoning faculties. The value of the mathematical sciences in logical training is often insisted upon, but to the writer it seems as if the biological sciences were even more important from this standpoint. In mathematics, given such and such premises, there can be but one conclusion; there is no alternative, while in zoölogical reasoning there is an element of uncertainty to be eliminated. Each fact observed must be weighed,

and its relative importance determined, before conclusions can be drawn, and even then it is frequently necessary to estimate the relative probability of two or more alternatives, thus giving an exercise to the powers of ratiocination which is utterly lacking in the remorseless logic of the mathematical theorem.

When this general foundation of facts and methods is obtained, more special studies are taken up; and since embryological research includes most of the processes involved, we will suppose that the student is next introduced to this fascinating field which is now so assiduously cultivated by scholars all over the world. As a rule, it may be stated that animals living on the land or in fresh water differ considerably in their mode of development from their near relatives in the sea. Many ancestral features which are retained in marine forms have become eliminated in the others, and hence the study of the growth of salt-water forms from the egg to the adult throws far more light on the relationships and ancestry of the different groups than does that of the terrestrial and fluviatile species. Again, the sea affords a wealth of life far beyond that of the land and fresh water, a wealth to be estimated not only in number of individuals but of species as well. Whole groups of animals are solely marine, while others are represented on the earth or in rivers and ponds by a few small and insignificant forms.

For this reason the student of embryology betakes himself every year to the shore, so that, while being recuperated by the sea-breeze, he may continue his studies and add to the total of human knowledge. Marine laboratories for this purpose are scattered the whole length of our coast, from North Carolina to Eastport, some being mere temporary affairs, others permanent stations. In 1885 public or private laboratories existed at Beaufort, Newport, Nantucket, Wood's Holl, Salem, Annisquam, Mount Desert, and Eastport. The absolutely necessary furnishings of such a laboratory are extremely few, but to them one may add as far as purse and inclination admit. There must be tables, chairs, and glass dishes, while each student must have a microscope and accessories. Then come a boat (a row-boat is sufficient for all ordinary work) and apparatus for collecting. Finally, a small stock of chemicals and apparatus for microscopical work complete the list of necessities.

Possibly the most common way for obtaining material for embryological study is by use of the skimming-net. This consists of a brass ring about a foot in diameter, to which is attached a net of fine gauze and cords for dragging it behind a boat. The whole operation of skimming is very simple. Two persons are required, one to row the boat, the other to attend the net. The latter allows the net to trail behind, keeping the cords so that part of the mouth is above and part below the surface of the water, so that as much as possible of the surface-water will be strained through the gauze. At intervals the net is

hauled in, turned inside out, and rinsed by immersion and agitation in a bucket of water kept in the bottom of the boat. In this way everything entangled in the meshes of the net is transferred to the pail. The net is again put out and the operation repeated.

Skimming may be performed at any hour of the day; but in the daytime the forms collected will differ considerably from those captured at night, and, besides, will not be nearly so numerous. The best place for skimming is a spot where two tidal currents meet, forming a line of scum upon the surface; the best time is in the evening, when the surface of the water is calm and smooth. Then the wealth of forms and individuals is almost incredible, and no one who has never seen the operation can have the slightest conception of the results. Each time the net is hauled from the water it shines like molten gold from the phosphorescence of the myriads of animals by which it is covered. On closer examination it is seen that spots of other colors exist among the prevailing yellow light: bright red, blue, bluish-green, emerald-green, and white occur, and after some experience one learns to recognize the presence of a few species by the color of the light.

Only two or three hauls of the skimming-net are necessary to insure an abundance of material for study, and at no time need the student spend more than half an hour in this work, while frequently ten or fifteen minutes are ample. The laboratory is now sought, and the contents of the bucket in which the net was rinsed are poured into shallow glass dishes placed between the student and a lamp. Then, and not till then, does one begin to realize the enormous amount of life in the sea. In half an hour's skimming not a thousand gallons of water will pass through the net, and yet but a single glance at the dishes convinces one that millions—yes, millions—of individuals have been captured! The water is roily with minute animals and embryos, whirling, dancing, and jerking about in the strangest manner.

On different nights the relative proportion of forms will vary. To-night not a single specimen may be taken of a species which last night was very abundant; but at all times a large proportion of the captures will be found to be copepod crustaceans—small forms not over a quarter of an inch in length, which swim about in a jerky manner by means of violent strokes of their long antennæ. To enumerate all the forms which might be taken by skimming would prove a difficult task, but some of the more prominent forms are readily recognized by the peculiarities of their motions. The crustacea move by jerks, the embryo worms and mollusks, on the other hand, whirl away in a mazy waltz; while the jelly-fish swim lazily away by the languid contractions of their umbrellas.

While a general view of the results of surface-skimming is interesting and instructive, our student has other work before him. He is to take one species of embryo and follow it through its transformations. Soon after the dishes are placed before the light, most of the forms will

be found congregated at the lightest side of the dish. A lamp seems to exert the same fascination on them as on the moths of a summer's night. The student, armed with a magnifying-glass, now picks out from the dish the forms he desires to study by means of a medicine-dropper, and transfers them to a separate dish, where they may have an abundance of water, and, when sufficient material has been picked out, the real study begins.

The first thing is to ascertain everything of the external and internal structure that can be seen in the living animal. For this purpose it is placed on a glass slide in a drop of sea-water and carefully studied under the microscope. In this, as in all embryological work, drawing is absolutely necessary. Pages of description will not take the place of pictorial representation. After the whole is studied, then comes a study of the different parts, drawings and notes being made of each. An embryo is continually growing, and it becomes necessary to take into account every stage of growth. The embryo of to-morrow will be different from that of to-day, and the changes must be recorded. Some of the embryos are therefore kept, the water being changed, as often as necessary, and these serve for to-morrow's study, the drawings of to-day furnishing a basis of comparison. In many cases it is a comparatively easy task to rear embryos until the adult condition is recognizable, but at other times it is found impossible to keep them in confinement for more than two or three days. In the first case it is an easy task to identify the forms studied, but in the other the difficulty is considerable. Subsequent skimmings must be made in the hopes of securing the later stages of development, while an endeavor to find the animal which produces the eggs frequently meets with success. Comparison with the studies of other investigators is also an important aid to identification.

If, however, the eggs are taken directly from the parents, this trouble is wholly avoided, although other difficulties are introduced. Suppose, for instance, that one wishes to study the development of one of the fishes, the first step is to obtain males and females with the generative products ripe. A gentle stroking will serve to expel both eggs and milt, and then these are mixed together and "artificial impregnation" is affected. In the case of worms, oysters, and clams, the same result can be obtained by mincing the generative organs of ripe males and females, mixing them together, and then straining off the larger portions which, by their decay, would soon pollute the water. In the case of crabs and shrimps the eggs are borne attached to the abdominal legs of the mothers, and by capturing these females an abundant supply of material can be obtained. The parents can readily be preserved alive in lobster-cars or similar contrivances, and furnish eggs as they are needed.

Artificial impregnation is a very valuable process, for, by its aid, every stage in development may be obtained. Eggs and milt may be

mixed under the microscope, and all the phenomena of the maturation of the egg and its impregnation can then be followed as well as the processes of segmentation which result in the conversion of the single-celled egg into the many-celled embryo. Interesting as a description of these phenomena would be, we must pass them by, for we have not yet described one of the most important processes of study.

Studying embryos, even the most transparent ones, by simply watching them under the microscope, leaves many features of the method of formation of the internal structure unknown, while in the case of opaque forms it reveals not a single feature except those of the surface. A knowledge of these internal points is, however, just as important as of the external modifications of form. In many, yes, in almost every case, the embryo is too small to be dissected, but by converting it into a series of slices or sections, and then studying these, structures and processes of growth are revealed which otherwise would remain entirely unknown. This method of section-cutting and the processes of preserving the sections thus obtained is almost entirely a growth of the last ten years. It is true that for a long time naturalists have resorted to it, but so crude were the instruments and so faulty the *technique* that section-cutting could hardly be said to exist in comparison with its importance to-day.

Here, as elsewhere, details would be out of place in an article of this character, but an outline of the processes involved in section-cutting will show the capacities of modern research as well as the methods which our student must master before he can take his place among the advanced workers of to-day. It must be said, in passing, that for every form some process is best adapted, and that what works well for one is often utterly unsuited for a closely related species. No general rule can be laid down by which the student can at once say that such and such methods are best adapted to give good results; the exact course of procedure in any case can only be determined by experiment.

Were it attempted to cut the fresh egg into sections, the result would be an ignominious failure. There are various preparatory processes necessary, and in all of these care must be exercised that the reagents employed do not produce abnormal effects. First, the egg must be hardened, and here there is a choice among a number of chemicals—alcohol, chromic acid, bichromate of potash, osmic or nitric acids, corrosive sublimate, etc.—each of which has its especial advantages and disadvantages. Even in the method of killing the egg previous to hardening, there are a number of methods to choose from. The hardening reagents all serve to kill, but not equally well, for they do not all work with the same rapidity. In the use of all, care has to be exercised to prevent contraction.

Were we to cut the hardened egg, our sections, without further treatment, would reveal but little, for they would be very transparent,

and one portion would closely resemble another. So staining is resorted to, and, where practicable, it is preferable to stain before cutting the sections. Of stains for microscopic purposes there are many, and the value of each depends upon the fact that the different elements of cells and tissues will absorb it in varying quantities. Most used of all is some preparation of carmine which stains certain portions red, leaving others uncolored. Of these carmine solutions the student has no less than twenty to choose from. Next in order comes hæmatoxylon, or extract of logwood, which, when combined with alum, stains certain portions blue or purple. Osmic acid also stains a brown or a black, according to the structure and the length of exposure. Nitrate of silver is also frequently used for certain purposes, while of the anilines only eosin and Bismarck-brown have any great value.

In order to section the egg we must employ some means to hold it firmly, and for this purpose various substances are employed, paraffin or celloidin being the most common. The requisites of an imbedding substance are that it be possible to make it thoroughly impregnate every part of the egg, and also that it be of such a consistency as to be readily cut into the thinnest sections. The egg is imbedded in paraffin by completely replacing all the water in it by alcohol, this in turn by some solvent of paraffin, as turpentine or oil of clove, and then by keeping it for a time in melted paraffin. Then egg and paraffin may be cut as if only paraffin were present. In the case of celloidin (a solid form of gun-cotton) the intermediate reagents are alcohol and a mixture of alcohol and ether. The process involves some time to accomplish thoroughly, and here, as elsewhere, neglect of details is sure to result in failure.

In order to cut the sections, special instruments (microtomes they are called) have been devised, and are now made of a high degree of accuracy and excellence. So delicately are they made, that it is possible to cut an egg into a series of sections so thin that it would require twenty-five or even more of them to equal in thickness the paper on which this magazine is printed. In the early days of section-cutting no such facilities were available, and the apparatus described in the hand-books of microscopy even five years ago were utterly inadequate to produce good results. Of modern microtomes there are now four distinct types in use, two having the knife stationary, the other two having it moved through a fixed and definite plane. It is not necessary to describe these here; those who wish may find accounts and figures of them in recent works, like Whitman's "Methods of Research in Microscopical Anatomy and Embryology."

Very recently a new "kink" has been introduced into section-cutting which has relieved the student from a great deal of drudgery. It has been found that by trimming the block of paraffin square, and by having the edge of the section-knife at right angles to the line of stroke, the successive sections would adhere together by their edges,

and form long ribbons, and that thus a large number of sections could be mounted as readily as one by the former method. For some purposes this serial section-cutting" has no especial advantages, but where it is desired to preserve every section it is indispensable. To mount them, however, requires special processes. The one most in use is the following:

A glass slide is coated on one side with a mixture of clove-oil and collodion, which forms a viscid, sticky surface. On this the ribbons of sections are laid and then the whole is exposed for some time to a gentle heat in a water-bath. This melts the paraffin and allows the section to drop into the sticky mixture where every part, even if separate from the rest, is firmly and securely held in its proper position. A continuation of the heat evaporates the clove-oil until the sections are fastened to the slide by a thin film of pure collodion. The paraffin is now washed away by turpentine or chloroform, Canada balsam and a bit of thin glass are applied, and then every section is permanently preserved and ready for study, it may be immediately or in a year or two.

Usually most of the time spent in a summer marine laboratory is devoted to studying the external features of development and in preparing material and slides of sections which can be examined more carefully later. With a slide which contains all of the sections cut from a single egg the student can reconstruct all the details of the embryo and can trace the course and limits of every organ and vessel. By comparing this with the sections of a later and an earlier stage, he sees how the organs arise, and how during growth they are modified in size and shape, as well as in their relations one to another. In studying the living embryo, time is not taken into account. It usually happens that material is obtained late in the day or in the evening. It takes no rest, but develops minute by minute, hour by hour, and the student, if he really wishes to master his problems must be reconciled to turn night into day. His egg is changing constantly, and, with pencil in hand, he sits with one eye to his microscope, watching the growth. Hour after hour thus passes away, each minute revealing some new feature, until at last his eyes tire and he is forced to quit. He seeks his bed with regret, for he has been compelled to leave some of the most interesting objects that the human eye ever saw. Consider for a moment the differences between an adult fish and its minute egg, clear as a drop of dew, and then try to imagine the changes which are necessary to convert the one into the other. Such things as these our student was forced to leave, and leave, knowing that the egg would not wait for him, but on the morrow would be far advanced, and there would be a great gap in his notes. While he was looking, it seemed as if he could almost see actual personal life. Changes were constantly occurring: now he saw a cell divide into two, just as though a knife had passed through it; again, he was seeing the way the cells thus

formed were arranging themselves in layers and building up the embryo. Such scenes as these have a fascination beyond description, and the student can not repress the feeling that, could he wait a little longer, or were his microscope a little more powerful, he could actually see the force that accomplished these marvelous results. On the morrow, when he returns to his study, the feeling is the same, and no matter if he be witnessing some phase of development, even for the hundredth time, he is as interested as at first. At such times it seems as if the solution to the great problem, "What is life?" were really close at hand.

So far it has been an easy task to describe the process of conversion of an untrained person into an original investigator, but there is another side—a psychological one—which baffles description. All that is necessary in order to perform the various operations which have been thus briefly outlined are power of observation and skill in manipulation; but the facts thus gained must be interpreted in order to render them of real value. A paper which merely details the facts observed of course has its value; but if it adds a comparison of them with the phenomena which occur in other forms, and tells or even suggests their meaning, it then takes a far higher rank. This, however, takes thought, and who can describe the way in which one thinks?

The student tries to master every fact in the development of his embryos, and then compares these facts with what was already known of the development of other forms. In this way he recognizes similarities and differences, for both of which explanations are to be sought. Even in the development of the specimen studied there are many phenomena which have their own meaning, and which, properly interpreted, throw much light on its ancestry and line of descent. In general terms this interpretation is effected by framing an hypothesis which will embrace some of the facts, and then testing it in every conceivable manner. When an objection arises, the first step is to see if it really be founded on fact, or upon a misconception, and then, if it be valid, the attempt is made to reconcile it with the hypothesis. It frequently happens that several hypotheses are formulated before a satisfactory one is found.

Such in brief outline is the training, or rather a part of the training, which is necessary to make a naturalist to-day. The time is past when one can collect a few bugs or shells and then straightway proceed to describe so many new species. Description of species is a necessary work, but it is not the highest kind of work. Far more important, far more ennobling, far more interesting are the deeper problems of how an animal grows, why it grows in the way it does. The training necessary for work of this character requires as long a time, as much patience, and as much perseverance as does any of the so-called learned professions; but when one becomes an original investigator there is no respite. It means continual work, continual study. If one stop,

even for less than a year, he can never catch up. Others have been at work while he was idle, and he is left behind. Pecuniarily a naturalist's work does not pay; the same amount of energy and ability spent in any other direction would bring in ample recompense, but here it does not. It does, however, have its own reward: every new fact discovered gives the student far more pleasure than any money could; each new advance into the *terra incognita* of Nature lightens the inconveniences of poverty.

And now the question may arise, What is the use of discovering the secrets of Nature if there be no money in it? Yes, that is it. Everything must be reduced to a basis of dollars and cents! The utilitarians who propound such questions do not and can not see any value in learning for learning's sake; it must bring some pecuniary reward. In some instances it is readily seen that such studies have a direct influence in curing or ameliorating some of the ills that human flesh is heir to; in other instances their exact bearings are not immediately apparent. Just one hundred years ago an Italian physician, Galvani by name, discovered some facts which, while interesting, must have seemed at that time wholly without practical bearings. To-day no one can deny that they were fraught with great good to mankind. What would the world be without electricity as a servant? Yet Galvani's experiments contained the germ of all our numerous electrical discoveries. Who can say but that biological studies are to have an equal value in solid gold?

CELEBRATED CLOCKS.

By FREDERIC G. MATHER.

WHEN the Emperor Charles V of Spain retired to the Monastery of St. Yuste, he took with him Torriano, his clock-maker, in order to while away the time by constructing the movements of clocks. So wonderful were some of the pieces of work which they made, that the monks would not believe any one except the devil had a hand in them, until the machinery was shown to them by the ex-emperor. It was ordered by Charles that when he should die all of these clocks should cease running—and it is said to be a fact that his orders were obeyed.

Another king of Spain came to Geneva to see a clock which had been made by Droz, a merchant of that city. Upon the clock were seated a shepherd, a negro, and a dog. As the hour was struck, the shepherd played upon his flute, and the dog played gently at his feet. But, when the king reached forth to touch an apple that hung from a tree, under which the shepherd rested, the dog flew at him and barked so furiously that a live dog answered him, and the whole party left in

haste. Venturing to return, one of the courtiers asked the negro, in Spanish, what time it was. There was no reply; but, when the question was repeated in French, an answer was given. This frightened the courtier, who rejoined his companions, and all of them voted that the clock was the work of the evil-one.

Upon the belfry of the Kauthaus, in Coblentz, there is the head of a giant—bearded, and helmeted with brass. The giant's head is known as "the man in the custom-house"; and whenever a countryman meets a citizen of Coblentz away from that place, instead of saying, "How are all our friends in Coblentz?" he asks, "How is the man in the custom-house?" At every stroke of the bell which sounds the hours upon the clock, the mouth of the giant opens and shuts with great force, as if it were trying to say, in the words of Longfellow, "Time was—Time is—Time is past."

The "old clock of Prague" stands near the old Hussite church—the machinery forming a part of the original tower, and the egg-shaped dial being shown on the street. It was the work of Hanusch, who died in 1499. So jealous of the other cities were the citizens of Prague, and so afraid were they that the other cities might bribe Hanusch to build as good a clock somewhere else, that they declared he was insane, and put out his eyes. The dial, which is between six and eight feet across, has a number of hands which mark not only minutes and hours, but also days, months, years, and centuries. What else it will do has been told in this way by a poet:

"At the left of the dial a skeleton stands,
And aloft hangs a musical bell in the tower,
Which he rings, by a rope that he holds in his hands,
In his punctual function of striking the hour.

"And the skeleton nods, as he tugs at the rope,
At an odd little figure that eyes him aghast,
As a hint that the bell rings the knell of his hope,
And the hour that is solemnly tolled is his last.

"And the effigy turns its queer features away
(Much as if for a snickering fit or a sneeze),
With a shrug and a shudder that struggle to say,
'Pray excuse me, but—just an hour more, if you please?'

"But the funniest sight, of the numerous sights,
Which the clock has to show to the people below,
Is the Holy Apostles in tunics and tights,
Who revolve in a ring, or proceed in a row."

On the dial-plate of a clock in St. Mark's Cathedral, in Venice, the twenty-four hours of the day are represented by the signs of the zodiac and the phases of the moon. The Madonna is seated on a platform over the dial. Whenever a religious festival occurs, an angel comes out from a door at one side of the platform, blows a trumpet,

bows to the Madonna, and passes out at another door. The three wise men of the East then come in at one door, bow to the Madonna, and pass out. Two giants strike the hour on a bell, while the winged lion of St. Mark overlooks the whole scene.

We are told of a strange clock that is said to have belonged to a Hindoo prince. A large gong was hung on poles near the dial, and all about, upon the ground, lay a pile of artificial human heads, ribs, legs, and arms. The whole number of bones in the pile was equal to the number of bones in twelve perfect bodies, but the pile appeared to have been thrown together in the greatest confusion. "When the hands of the clock indicated the hour of one, out from the pile crawled first the number of parts needed to form the frame of one man, part coming to part with quick click; and, when completed, the figure sprang up, seized a mallet, and, walking up to the gong, struck one blow. This done, he returned to the pile, and fell to pieces again. When two o'clock came, two men arose, and did likewise; and at the hours of noon and midnight the entire heap sprang up and, marching to the gong, struck one after another his blow, making twelve in all; then returning, fell to pieces as before."

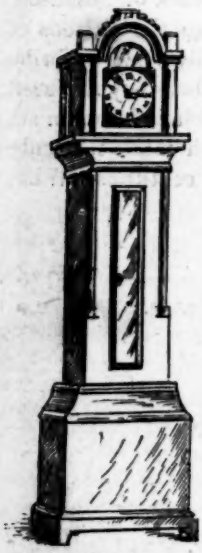
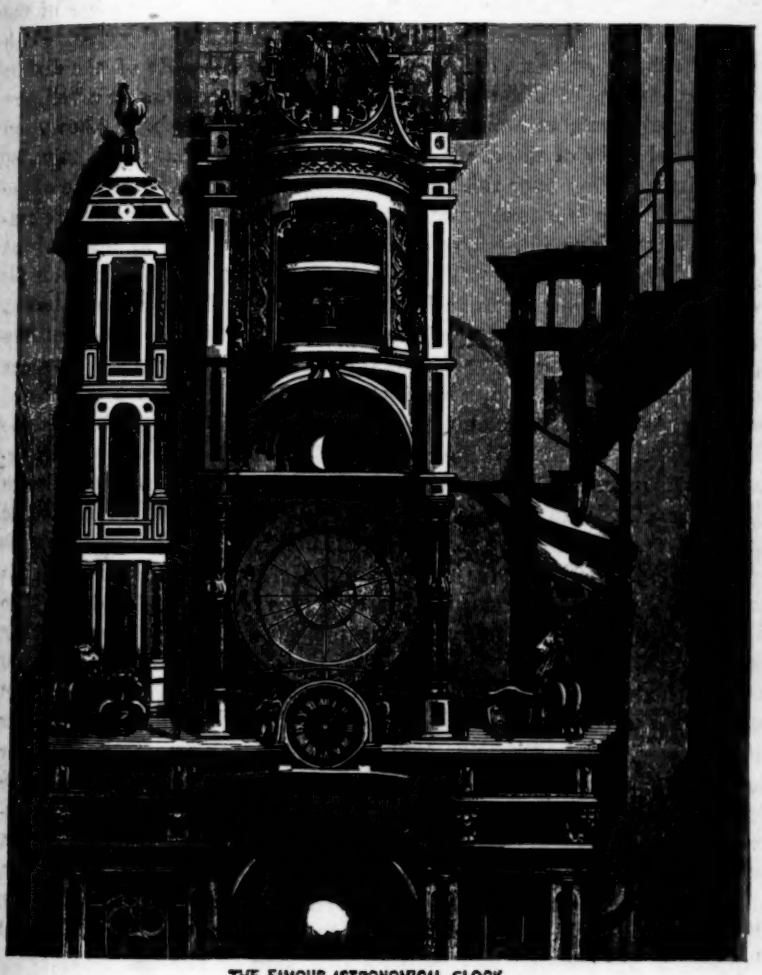


FIG. 1.—MY GRANDFATHER'S CLOCK.

An old traveler writes this description of a clock that he saw in Japan: "This clock, in a frame three feet high and five long, represented a moon landscape of great loveliness. In the foreground were plum and cherry trees and rich plants in full bloom; in the rear a hill gradual in ascent, from which flowed a cascade, admirably imitated in crystal. From this point a thread-like stream glided along, encircling rocks and tiny islands in its winding, but presently losing itself in a far-off stretch of woodland. In the sky turned a golden sun, indicating as it passed the striking hours, which were all marked upon the frame below, where a slowly creeping tortoise served as a hand. A bird of exquisite plumage, resting on a plum-tree branch, by its wings proclaimed the expiration of each hour. When the song ceased, a mouse sprang from a grotto near by, and, running over the hill, hastily disappeared."

By far the most famous clock in the world is the one that is hidden inside the cathedral in Strasburg (Fig. 2). The first clock—with automatic figures—was begun by Bishop Van Bucheck in 1352, and finished by Bishop von Litchenberg in 1354. The present clock was begun in 1547 by Christian Herlin, Nicholas Bruckner, and Michael Herr. The death of the two latter delayed the work, and it was not resumed until Professor Conrad Dasypodius, of the university, fur-

nished plans for its completion in 1570. The brothers Isaac and Josiah Habrecht executed the mechanical work; and Tobias Stimmer carved the wood casings and ornaments. The work was completed in 1574, under the superintendency of David Wolkenstein. It stands to-day—just as it has stood for over three hundred years—a very elaborate piece of workmanship, thirty feet high and fifteen feet wide



THE FAMOUS ASTRONOMICAL CLOCK.

FIG. 2.—THE FAMOUS ASTRONOMICAL CLOCK, STRASBURG.

at the base. On one side is a flight of winding stairs surmounted by five emblematical Corinthian columns. On the other side is a Gothic pillar, the panels of which are filled with paintings of human figures. In front of the base a large globe shows the equinoxes and the positions of the sun and moon. Another arrangement in the base shows the movements of the several planets. A calendar, also, shows what

are fast-days, holy-days, and feast-days. Above all of these interesting things there is a long opening which extends across the width of the base. On each day of the week a different figure appears at one side of this opening, at noon it is in the center, and at night it disappears altogether at the side opposite to the one by which it entered in the morning. The figure on Mondays is that of Diana; on Tuesdays, it is Apollo. Just above these figures, and in the very edge of the platform that forms the top of the base, is the dial of the clock which tells the hour and minute of the day. On either side of the dial sit two Cupids, one of whom strikes the hours and quarters on a bell, and the other reverses an hour-glass as each new hour begins. Above, and on the real body of the clock, is placed a dial containing the signs of the zodiac. Then over this there is a ball which shows the age of the moon—whether it is first quarter, or full, etc.—while overhead are concealed the various images, or automatic figures, that appear only at noon. What an eye-witness saw by waiting from eleven o'clock till noon has been thus described: "We viewed this wondrous piece of mechanism for an hour, and witnessed the following movements: At a quarter-past eleven the Cupid near the dial struck one; then, from one of the upper compartments ran forth a little child with a wand, and as he passed he struck one on a bell, and ran away (Childhood the first quarter). Round whirled the wheels of time, and the second quarter chimes; but this time it is Youth that passes, and taps the bell with his shepherd's staff twined with flowers. After we leave the second quarter, then Manhood strides forth, the mailed warrior, and smites the sonorous bell, ere he leaves the scene, three sounding blows with his trenchant weapon—the third quarter. Once more the hands tremble on the point of noon; the fourth quarter is here, and Old Age, a feeble, bent figure, hobbles out, pauses wearily at the bell, raises a crutch, and taps four strokes, and totters away out of sight—'last scene of all'; when, as a *finale*, the skeleton figure of Death, before whom all four have passed, slowly raises his *bâton*, which the spectators now discover to be a human bone, and solemnly strikes the hour of twelve upon the bell. While he is engaged in this act, a set of figures above him, representing the twelve apostles, pass in procession before the Saviour, who blesses each one as he passes before him in turn; and chanticleer, the size of life, perched upon the pinnacle of one of the side structures, lifts up his voice in three rousing crows, with outstretched neck and flapping wings; while the Cupid on one side of the dial reverses the hour-glass for the sand to flow back, and the other Cupid strikes the hour with his bell and hammer."

There are many other wonderful clocks in the world, but they are smaller, and they are not as well known as the Strasburg clock. An old time-piece in England records the age of all the planets by an arrangement which gives the exact revolution of each one. For instance, the little ball that represents Mercury goes around the circle

once in about three months; Venus, once in seven months; the Earth, once in a year; Mars, once in nearly two years; Jupiter, once in nearly twelve years; Saturn, once in about twenty-nine years; Uranus, once in eighty-four years; and Neptune, once in one hundred and sixty-five years. Besides giving the golden number, the dominical letter, and other interesting things, this clock gives the time when it is high tide at various points in Europe. A clock made by a Parisian consists merely of a glass dial, and two hands, which are balanced each with a ball on the other side of the center. These balls (Fig. 3) are only about an inch in diameter, and yet they contain all the machinery that turns the hands about. The back of the dial is a perfectly smooth surface. You may turn the hands round and round with your cane, and when you let them alone they will swing back and forth for a while, and then they will stop at exactly the right spot to show the true time. A clock in Brussels is so placed over a chimney (or pipe through which the air goes upward) that the draught keeps it wound up all the time.

FIG. 3.—PARISIAN CLOCK.

The most artistic clocks for mantels are, for the most part, made in Paris or Vienna. One variety has a tuning-fork for controlling the escapement. Another hides the working parts of the clock within a base that shows only the dial (Fig. 4). Upon this base stands a female figure holding a pendulum which vibrates without any cause that any one can see. But if the figure is taken off from its base it will be discovered that it rests upon a pivot which is connected with the escapement in such a way that it is swayed to and fro just a moment before the pendulum has reached the limit in the opposite direction. This sends the pendulum back again, just as you reverse the motion of a rocking-chair by leaning forward just before you have rocked back as far as you are going. Sometimes the female figure (Fig. 4) holds above her head a great ball, which is balanced by a pendulum that swings near her feet. The ball contains the clock, and inside of it is a small pendulum, controlled by a spring in such a way as to send the large pendulum back and forth after the manner of a rocking-chair. There are also clocks that are run by electricity instead of by weights.

FIG. 4.—PARISIAN CLOCK.

The largest clock in the world is the one in the British House of Parliament at London, known as the Westminster clock. Its four dials are made of iron and glass, in such a way that they can be brilliantly lighted at night. They are one hundred and eighty feet from the ground, and their diameters are twenty-two and a half feet—a size which makes them larger than any dials in the world save one, at the cathedral at Malines, and that one has only an hour-hand. The minute-hand of the Westminster clock jumps nearly seven inches every half-minute—this kind of action by a remontoir-train being considered better than the old way of having the wheels move all the time as they do in an ordinary clock. The train (Fig. 5) is about fifteen feet long

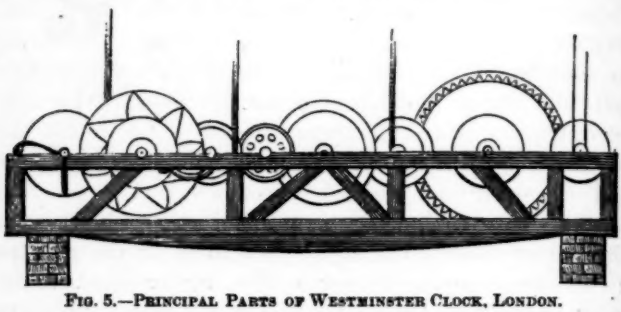


FIG. 5.—PRINCIPAL PARTS OF WESTMINSTER CLOCK, LONDON.

and nearly five feet wide. The escapement is known as the "three-legged double"; and any error is corrected at the Greenwich Observatory, whither the great clock telegraphs its time twice every day. The train of wheels that carries the hands is wound up once a week; but the train that controls the striking part is wound up twice a week. The great, or hour, bell is nine feet in diameter, weighs 30,000 pounds, and can be heard at a distance of ten miles. The quarter-hour bells can be heard four or five miles, and they weigh 8,000, 3,700, 2,800, and 2,350 pounds respectively. The present clock was first set going in 1859, and it cost $110,000. The cost of the movement of striking-work was $20,000; of the hands and dials, $26,500; of the bells, $30,000. The site of the clock has been occupied by some kind of a public timepiece for the past six hundred years. We read that on this spot the first Westminster clock was erected in 1298; and that in 1365 Edward III erected a tower containing a clock and a great bell, upon which the hours were struck.

If we inquire where the clocks that are made to-day come from, we shall find that France sends out the largest number, measured by a money value. Then come in order Switzerland, the United States, England, Austria, and Germany. In Germany there is a district known as the Black Forest, in which thousands of people follow the trade of clock-making, and so have their fathers and grandfathers for a great many years. In the United States, almost the only clock-makers, down to the year 1800, were Daniel Burnap, Eli Terry, Silas Merriman, Thom-

as Harland, Timothy Peck, and James Harrison—all of Connecticut. In those days an ordinary house-clock cost sixty or seventy-five dollars without the case, and this was because all of the works were made by hand. From these few clock-makers has sprung the great clock-making industry which supplies clocks that are sold cheaply, because the various parts are made by machinery. American clocks of this sort go all over the world, and even into the Black Forest! Fine and delicate astronomical clocks are also made in the United States. We hear of clocks that run in a vacuum, and which wind themselves; and of large clocks at a central point which drive other clocks all about the city by the force of compressed air. The latter are called pneumatic clocks. We also read of a magnetic clock which requires no power or force for its running save the magnetism of the earth.

There are many other clocks of American make that deserve to be mentioned, but we have not space enough to do so. We must be fair toward our own mechanics, by telling of three or four clocks that have been made in the United States. There is one known as the "Columbus Clock," because it was made by a citizen of Columbus, Ohio. The maker was only thirty years old when the work was done, and it had taken him eight years to complete it. The clock stands about eighteen feet high by eleven wide. It shows not only the revolution of the earth on its own axis, but also its position in its orbit about the sun. The positions of the other planets in their orbits are also shown. There are miniature models of the signing of the Declaration of Independence; of President Lincoln emancipating the slaves; and of the Strasburg clock. A wonderful walking-man is also one of the attractions.

Another American clock was made in Donaldson, Pennsylvania, by a native of Germany, who took seven years to whittle it out of a log. All around and below the dial there are groups of automatic figures. At the top is Napoleon, and the horse that is said to have eaten apple-dumplings. Both Napoleon and the horse (the automatons, I mean) partake of what are supposed to be dumplings. Then we have Captain Jack, chief of the Modocs, who summons his warriors by striking the hours upon a gong. Just below the dial Jonah is being swallowed by the whale, after having been thrown overboard from the vessel. In another part Christ is walking on the water toward a group of disciples that crowd the deck of a ship. Noah's ark, the "good fairy and the poor woman," and several other figures, go through their movements, while a music-box within the case of the clock gives forth appropriate tunes.

The most remarkable clock in America, if we consider the place in which it was built, is the one that was made by a miner in the Hallenback colliery, at Wilkesbarre, Pennsylvania. This clock was made out of bits of board and iron, and with the roughest tools that can be imagined. It was made nearly half a mile underground, and it occupied

the maker nine years before he could say it was done. The clock is about nine feet high, and there are sixty-three figures that move by machinery. There are only twenty-two moving figures in the Strasburg clock. On the front of the Wilkesbarre clock—the one we are speaking of—there are three shelves or balconies. Along the lower balcony a mounted general leads a file of Continental soldiers. The liberty-bell rings, and a sentinel salutes the procession. A door in the upper balcony opens and shows Molly Pitcher, who fires her historic cannon, the smoke of which is blown away from the interior of the clock by a fan. Then the portraits of the first twenty Presidents of the United States pass along in a kind of panorama, the Declaration of Independence being held aloft by Thomas Jefferson. On another of the balconies the twelve apostles go by; Satan comes out, and the cock crows for the benefit of Peter. When Christ appears, a figure of Justice raises a pair of scales, while a figure of Death tolls the minutes upon a bell.

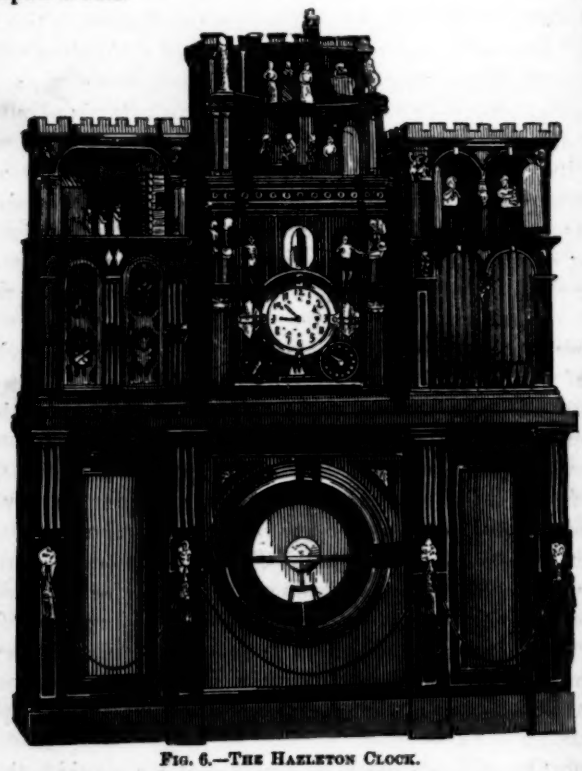


FIG. 6.—THE HAZLETON CLOCK.

All things considered, the most wonderful of all the large clocks constructed in America (Fig. 6) is the one made by a watchmaker of Hazleton, Pennsylvania—a piece of work that shows forty-eight moving figures, and that it has taken the lifetime of the inventor to produce.

The base of the clock contains a revolving horizon, which shows the motion of the constellations. A six-inch globe, representing the earth, turns on its axis once in twenty-four hours; and about this globe a moon completes the circuit once in twenty-nine and a half days. All the machinery for producing these movements is in plain sight. The central part of the case above the base contains several dials showing the tides, the season of the year, the phases of the moon, the day of the week, and the day of the month. The largest of these dials has the hours and minutes. Just over this dial there is an oval niche where Youth, Manhood, and Old Age appear in turn as the hour goes by. An alcove at the right contains Father Time with his scythe, bell, and hour-glass. An alcove at the left holds a figure of Death, which is ready to strike the hour with a thigh-bone upon a skull. Above these images are the doors where Christ, the Apostles, and Satan appear and disappear. The figure of Justice is close at hand. Still above the Apostles is an upper balcony where the three Marys appear. To crown all is a battlement, whereon a Roman sentinel paces back and forth. At the right of the main instrument above described a smaller tower contains an organ, which gives forth music during the march of the Apostles. Above the organ Orpheus and Linus appear with pipe and harp, but only while the organ sends out its strains. At the left of the main instrument a third tower represents the battle of Monmouth, and Molly Pitcher with her well-known water-keg.

The wonderful things that are done by the main part of the clock may be described thus: When the hour-hand approaches the first quarter, Father Time reverses his hour-glass and strikes one on the bell with his scythe. Youth then appears. Three minutes before the half-hour, a bell starts a tune from the organ. At the half-hour, Time again reverses his glass, strikes two on the bell, and Manhood appears. One minute afterward a chime is heard, and the Saviour steps forth from a door. The Apostles pass by—Peter in the center and Judas at the rear. The three Marys also come forth at the upper balcony and stand facing the spectators. Each one of the Apostles bows when opposite the Saviour, and the bow is returned. But Peter turns away—which is a signal for the cock to crow, for Satan to appear at the upper window, and for Justice to raise her scales. Judas does not look at the Saviour; but Satan follows behind him in the procession, to be sure that he does not bow, and then turns backward and disappears, only to reappear at an upper window. In fact, Satan appears in six different places. At the third quarter, Time strikes three, and again turns the hour-glass. Manhood passes by, and Old Age comes upon the scene. Three minutes before the hour the organ sounds once more; when the hour arrives, Death strikes the number on the skull, and the Apostles once more begin to move before the Saviour.

What is known as the "Rittenhouse Clock" is, in many respects,

a more wonderful piece of mechanism than the clock that we have just described. It is very much smaller than the Hazleton clock, and readily stands in the corner of an editor's office in Philadelphia. This editor—who controls one of the leading papers in that city—has more than fifty clocks, many of them very rare and costly, but the Rittenhouse is superior to all the rest. It was made in 1767 by David Rittenhouse, after whom Rittenhouse Square in Philadelphia is named. The clock has six dials. On the main dial in the center there are four hands, which point out the seconds, minutes, hours, and days—the latter giving one day more to February in leap-year. The phases of the moon are also given. The second dial shows the movements of the planets about the sun—each planet being represented by a golden ball. The third dial shows the moon revolving about the earth. The fourth dial shows how Saturn is getting along in his twenty-nine-year journey around the sun. The fifth dial shows whether the sun-time is fast or slow in comparison with mean meridian-time. The sixth dial discloses a combination of chimes which sound the quarter-hours, a choice of the tune to be played being had by turning a hand to any one of ten numbers, and a repetition of the tune is caused by pressing on a knob upon the dial.

A great many people nowadays appear to have taken a fancy to the tall clocks that are intended to stand in the corner of a room. They are sometimes called "grandfather's clocks"; and a great variety of them may be found all through the New England States, but more especially in Salem, Massachusetts, and Newport, Rhode Island. A number of English clocks from Virginia have recently come into the possession of the dwellers in Newport in a roundabout way. It seems that during the war of 1861 the negroes frequently stole the tall clocks and took them to their cabins. But, as the ceilings of the cabins were so very low, the clock-cases had to be sawed off, both at the top and at the bottom. Several years afterward a live Yankee came along and bought a great many of the shortened clocks, took them home, repaired them, and sold them at very high prices. Of course, all of these clocks give the old, new, and full moon, the tides, etc., and occasionally one of them has a music-box. A good story is told of a lady who drove a long distance into New Jersey to buy an old clock that would play tunes. Having brought it home, she found that it needed repairing badly; and so she took it to a repairer of clocks. Now, this repairer did not know how important it was, in the mind of the lady, to have the clock play very old tunes. Therefore, when he saw that the musical-box part of the clock must be replaced with something else, he put in a cylinder that contained several modern tunes. When the clock had been repaired it was sent home. The lady called in her friends to congratulate her upon her purchase. All of the visitors waited eagerly for the old tunes to be played; but, instead of that kind of music, the machinery struck up "The Babies on our Block"!

There is a very delightful way in which you may tell the hour of day by means of flowers. And this is really the most wonderful of all the clocks that have been or can be made, for it requires no winding and no weights, and no hands and no wheels. There are twenty-four varieties of plants whose blossoms open successively at the different hours of the day and night. I will mention only three or four. The African marigold opens at seven in the evening and closes at four in the morning; but, if it does not open, the next day will be rainy. Many varieties of the water-lily close and sink into the water at sundown, to arise and bloom at sunrise. The day-lily opens at five o'clock in the morning, and the morning-glory a little later. The night-blooming cereus opens only at night, and it closes long before the first streak of dawn.

COMPARATIVE PSYCHOLOGY: ITS OBJECTS AND PROBLEMS.*

By T. WESLEY MILLS, M. A., M. D.,
PROFESSOR OF PHYSIOLOGY IN McGILL UNIVERSITY, MONTREAL.

THE term comparative psychology, in its modern sense, gives us the widest desirable scope as including all that pertains to the mind or soul of the animal kingdom. It may have been at one time considered as highly impertinent to ask whether the lower animals possess mind, and to substitute the term soul would have been dangerously suggestive of heterodoxy of a type rapidly to be extinguished. However, few persons of any degree of culture will now be found prepared to deny that the inferior animals have minds. The questions now to be settled are: What kind of minds? In how far do they resemble, and in how far differ from, our own? Few, it is true, have considered that they sufficiently resemble the human mind to make it worth while to investigate the subject at all. Probably the great mass of persons have been led to believe that man does and always has occupied a distinctive and wholly isolated position in the universe of life—a center around whom and for whom all other forms exist. This view seems to me totally unwarranted by the state of our scientific knowledge at the present day. Further, it is a view not only without scientific foundation, but calculated to lead to pernicious practical results.

By experiments on the lower animals, and by this means almost wholly, has the science of physiology been built up. We argue from the case in animals to the case in man, and consider the inferences thus derived valuable, even final—possibly too much so; but we are

* A presidential address delivered before the Society for the Study of Comparative Psychology.

apt to ignore the psychological similarity. From experiments on the brains of the lower animals we argue as to the nature of the brain of man. Why not pursue the comparative method for the soul?

This condition of things can be traced to the influence of views still surviving, unscientific, as we believe, as to man's origin and place in the universe. At all events, such views exist and influence practically our treatment of the lower animals. Where man is concerned, their rights are very seldom considered. The question is not raised as to whose rights are paramount, but it is tacitly assumed that when man is involved the brutes have none. That such views have been up to the present time operative to the neglect, and often the positive annoyance, if not the actual persecution and death of unoffending creatures, will be perfectly plain to any one who will take the pains to examine into the case.

If there is to be order in the universe, it must be conceded that where respective interests clash in certain cases, that interest, and that creature of less importance must give way to the one of greater importance; but man can never act righteously to his fellow-creatures lower in the animal scale, till he recognizes that he is of them not only in his body but in his mind; in other words, that they are truly fellows, or, as some one has expressed it, "poor relations." But let this not be said in any pitying sense, for it can be most clearly shown that in not a few respects not only are these "poor relations" equal but superior to man.

Physiologists have long been familiar with the higher development of the senses in animals below man. There is not a single sense that man possesses in which he is not excelled by some one animal, often immeasurably.

Many of the performances of the lower animals, if accomplished by men, would be regarded as indications of the possession of marvelous genius. In the brutes they are regarded as the outcome of "mere instinct," by which is meant an endowment acting blindly and incapable either of philosophic explanation or of modification. While the fact seems to be that instincts, as they exist, are the result of inherited experiences accumulated through considerable periods of time; that they may be modified, and are constantly being modified by new experiences; that they may be lost or replaced; and much more that we have still to learn. Many of the instincts of animals are so far removed from any knowledge or faculty we possess that they are at present inexplicable. But man must learn to say, "I don't know," about a great many things still, instead of assuming the validity of explanations which are not true solutions at all, but mere assumptions.

And at this point allow me to indicate a danger that should make us cautious and modest in attempting to explain the behavior of animals. We infer from our fellow-man's behavior similarity of motive and mental processes to our own under like circumstances. We find,

the more experience we have, that we are often at fault as to both. And when we are more free from the thralldom of so-called systems and methods in education, we may learn that the activities of the human mind can not be reduced in all persons to precisely the one plan, like so much clock-work. This may mar somewhat the completeness and beauty of our philosophy of education, but it may also in the end conduce to human progress by providing the greater freedom, and end in insuring an individuality of character which seems to be now rapidly disappearing. Now, if individual men so differ in psychic behavior, how much more is it likely that still greater differences hold for the lower animals! An objection may be based, however, on this to the whole study of comparative psychology. The objection holds to some extent even for human psychology; but, as we infer, similarity of behavior in men to denote similarity of inner processes, so are we justified in the same as regards the lower animals, though it must be conceded somewhat less so. We must always be prepared to admit that there may be psychic paths unknown and possibly unknowable to us in the realm of their inner life. But if we regard man as the outcome of development through lower forms, according to variation with natural selection—in a word, if a man is the final link in a long chain binding the whole animal creation together, we have the greater reason for inferring that comparative psychology and human psychology have common roots. We must, in fact, believe in a mental or psychic evolution as well as in a physical (morphological) one.

It is not inconceivable that special faculties which do not exist in the lower animals have been implanted in man; but the trend of investigation thus far goes to show that at least the germ of every human faculty does exist in some species of animal. Nor does such a view at all derogate from the dignity of superior man, while it links the animal creation together in a way that no other can. It opens up the subject for genuine scientific study; it tends to beget a respect for the lower creation, which, while it fosters modesty in man, also furnishes a foundation for broader sympathy with those lower in the scale. The opposite view may lead to our pitying the brute, but can scarcely yield as good moral fruit. Let but an individual man assume that by virtue of something he possesses he is radically different from his fellows, and what is the result? Your genuine aristocrat (in feeling) is a sad stranger to humanity in general.

But where shall we draw the line? Formerly the line was drawn at reason. It was said the brutes can not reason. Only persons who do not themselves reason about the subject with the facts before them can any longer occupy such a position. The evidence of reasoning power is overwhelming for the upper ranks of animals, and yearly the downward limits are being extended the more the inferior tribes are studied. Perhaps the highest faculty man possesses is that by which he generalizes and forms conceptions of the *abstract*. That animals

have imagination or the power to frame mental pictures of absent objects, the grief of the dog at the absence or loss of his master amply proves, as does also the capacity of animals to dream. If, as some assume, abstraction is a necessary part of reasoning, then it must of course be conceded that animals have the power of framing abstract conceptions. There is a certain amount of evidence that some animals can count within narrow limits. It is scarcely possible to account for the conduct of the horse, dog, elephant, and ape, under certain circumstances, without believing that they have the power to generalize upon details. Once concede the power to form abstract ideas, and there is then the basis for any other faculty man possesses that is considered usually as peculiarly his.

Have animals a moral nature, or are they capable of forming a conception of right and wrong? The answer to this introduces the question as to method of comparison. Should the highest of the inferior animals be compared with the most civilized races of men, or with man in his most degraded condition? That neither of these comparisons is just, can be shown. As capacity for education is one of the best evidences of mental ability in both man and inferior animals, and as man's civilization is the outcome of his own intellect, he must be credited with this as evidence of his superiority.

It is to be remembered, however, that each marked advance in progress has been made by the few great intellects that have appeared, and only accepted, not originated, by the many; that but for permanent records in language, much of man's civilization would have been lost as rapidly as acquired; that man's civilization is the growth of thousands of years, beginning with a condition of things scarcely if at all higher than that now known to some tribes of animals; that what any child becomes is really largely dependent upon the training it receives; the child of the savage, and that of the civilized man, can not be compared any more than the latter and the inferior animals. Now, the reverse of all this holds for the lower animals. So far as any systematic training from man is concerned, they are very much as they were thousands of years ago. Before it were possible absolutely to compare the highest man and the highest animal, it would be necessary that for ages the effect of culture should be tried on the lower animals. The astonishing results achieved in the lifetime of a single animal, and the results attained by the creation of hereditary specialists as among dogs, put the whole matter in a light that shows our usual comparisons to be somewhat unfair. If the highest among dogs, apes, and elephants be compared with the lowest among savage tribes, the balance, whether mental or moral, will not be very largely in man's favor—indeed, in many cases the reverse.

We are not contending for the equality of man and the rest of the animal kingdom; even assuming that the child and the dog have equal advantages, the child will still be in many respects superior to

the dog; but we are desirous of pointing out how much has been overlooked in all these comparisons between man and the lower animals. It will be noticed that all those species of animals which have for ages been in contact with man, have made great advances over their wild progenitors, evidencing a capacity for education—mental and moral—which is one of the best demonstrations of superiority.

The assumption that man is only accidentally the superior of the brute would but lead to confusion, for it must be admitted that there is a scale, and that man ranks first. We are simply desirous of doing the lower creation that justice which we feel assured has not yet been allowed them, and of seeing the human family interested in those that we think scientific investigation is proving constantly are much more our fellow-creatures than has generally been supposed.

If we compare the intelligence and general rectitude of behavior of our best races of dogs with the same in any of their wild carnivorous allies, we are astonished at the great difference in favor of the dog. To what is this due? Largely to what he has become by virtue of association with man for hundreds if not thousands of years—that is, to education, after a fashion. Nor is such influence confined to the dog. Any observing person, of moderate experience in travel, can call to mind numerous instances of members of different classes of animals trained to the performance of many feats demanding intelligence. But, while in an irregular way dogs have been trained to certain duties for the benefit of man for a considerable period, it can not be said that any one of the tribes of the lower animals has ever been subjected to any such mental or moral discipline as man receives and has received for long ages. We have ample evidence, in the condition not only of savage man, but in the neglected classes of large cities, as to what man would be without such culture. Sufficient has been said, it is believed, to show that we are not yet in possession of enough facts to enable us to determine exactly the limit of mental and moral capacity in the lower animals. As yet, we neither know adequately what they are or of what they are capable. Both these subjects are worthy of human investigation. Their elucidation must tend to give man a better knowledge of himself, if only by contrast.

To return to the question of the moral nature of animals. The study of the dog alone, both in the light of observations accumulated in the literature which are often true of special individuals in a degree not of the average animal (a fact which does not, however, at all invalidate their force), the study of any dog we may ourselves own, can not but convince us that a sense of right and wrong is possessed by that animal. It may be that the dog does not rise to these conceptions as understood by the learned divine discoursing from the pulpit; but neither does a large proportion of the congregation when transacting the business of the week. It may be, and perhaps is, largely true that the right with the dog means what is in accord with his master's

will; that is, the dog may end at the stage in which every child, even the most highly endowed, is found at *some* period of his development. It is a condition unquestionably in advance, by far, of that of scores of tribes. Moreover, as in the child and the less endowed morally of men, even such ideas of the right are powerfully operative in producing courses of useful conduct. They lead to action on the one hand, and to restraint on the other, instances of which, in the case of the dog, are abundant, and some of them of a most touching, we might almost say ennobling, character. To affirm that the idea of right and wrong of the lower animals does not rise above the hope of reward and the fear of punishment is not to keep to the facts, unless we include as the only reward, in many cases, the master's approbation, and the only punishment his displeasure. When a child arrives at such a stage of feeling, most persons would not be inclined to deny it a moral nature and a very good one, too. We might almost speak of a dog having a religion, with man as his deity. But as a whole host of qualities—some of them difficult to classify—go to make up the character of the human individual so developed and balanced as to deserve the epithet "gentleman," so there are many qualities in the best specimens of the canine race that we can practically appreciate better than define.

In all such discussions it must be borne in mind that if we adopt the theory of organic evolution we are almost bound, of necessity, to a belief in the origin and gradual development of mind from the faintest glimmerings of consciousness, in the simplest protoplasmic creatures; and that system will be most philosophical and complete which can fill up the gaps between the lowest manifestation of any quality and the highest. Hence, many are inclined to believe that the great distinction between man's faculties and those of animals lower in the scale is *difference in degree and not in kind*, certainly in so far as they run parallel. Such a view does not prevent our conceiving of additional forms of psychic activity not represented in man as the possession of the brutes. That such seems probable will appear when we discuss some of the problems still demanding solution. Nor does such a view imply that there may not be avenues of knowledge of a special kind open to man which are closed to those lower in the scale, such as a special revelation from a higher source. So far as we see, indeed, there are no theological difficulties any more than with evolution as ordinarily applied to animal and plant forms.

Man's present superiority over the lower animals is traceable in large part to his eminently social tendencies, resulting in the division of labor, with its consequent development of special aptitudes and its outcome in the enormous amount of force which he can, on occasion, bring to bear against the various tendencies making for his destruction. Indeed, the isolated individual man is scarcely as well prepared in the struggle for existence as most other animals. But the

extent to which animals do continue, it may be in pairs or in larger numbers, to defend themselves against enemies; hunt down prey; rear young; elude enemies; overcome difficulties in travel; work in concert in the preparation of dwellings, and in many other instances, has been but inadequately considered. And in many such cases it is quite impossible to explain these things by that refuge of the unthinking or prejudiced, "instinct." The limits of an address of this kind do not, of course, permit of detailed evidence being adduced for the views maintained. Such evidence is, however, within the observation of all to some extent, and is, so far as the literature is concerned, found in elaborate form in the admirable writings of Romanes and Lindsay more especially. Thus much by way of clearing the ground, of preparing the mind for a careful and earnest study of our fellow-creatures of the lower grades, without prejudice and without fear of any loss of self-respect by the concessions we may be obliged to make.

As to how, so far as the study of comparative psychology itself is concerned, the objects of this society may be best advanced, let me now endeavor to indicate briefly. A great part of the material available is found in literature of very varying reliability. In many cases there is so obvious a prejudice in favor of the particular animals whose performances are described, that very large deductions must be made. We shall do well to be more than cautious in what we accept. At the same time much that can not be regarded as wholly reliable may prove suggestive and serve as the starting-point of investigations. But there is no reason why many points now bearing the character of uncertainty and indefiniteness might not be submitted to the test of experiment. Doubtless not a few supposed facts would vanish into thin air if subjected to such examination. However, I must at the same time state that a careful perusal of the accounts of the experiments of even the most skillful investigators by this method, with its clearly defined but artificially arranged conditions, has convinced me that such do not wholly meet the case. They bear with them the danger of fallacy against which one must constantly be on the watch. It must always be considered that the great question is, not how an animal's mind *may* act, valuable as that may be, but how it normally *does* act; that is to say, what are the natural psychic processes of the class of animals under investigation? The same cautions, in drawing conclusions, must be observed in the allied science of physiology, one in which the conditions can be much more accurately regulated. Plainly, it will be desirable to keep our *facts* very sharply apart from our explanations. The science of psychology is a very youthful one, that of comparative psychology still more so; and, at the present stage of the science, any one who contributes a single fact will be a real friend to their progress. We must endeavor to secure a large number of correspondents who will furnish accurate accounts of phenomena in this realm, of which they have been themselves the observ-

ers. We must place all material coming at second-hand by itself, not as worthless, but as calling for special scrutiny. But so long as we have facts only, we have no science; such, indeed, are as the wood and stone for the building, and, unless worked up into scientific form, may prove an incumbrance. Let me, then, briefly indicate some of the problems that have seemed to myself and others as most urgently demanding solution.

One of the questions still far from clear is that which we had under discussion last year, viz.: In how far can the lower animals understand man's various forms of expression, especially his spoken words? *A priori*, we should not expect that creatures unable to invent words should have the capacity to understand them in the sense in which man himself does. I am inclined to think that more has been claimed for the inferior races of animals in this direction than an exact examination of the subject will warrant. On the other hand, we have probably very much underrated their capacity to comprehend our various forms of unspoken language. The subject calls for close observation. A kindred problem is the degree to which various kinds of animals can communicate with one another. This is a much more difficult subject, and it may prove that the creatures we despise as so very much inferior may have modes of subtile communication which we are, possibly, incapable even of comprehending.

The whole subject of the senses of the lower animals is a field for investigation both by the psychologist and the physiologist; all the more important, as it is scarcely possible to understand one form or degree of sensation adequately, except by comparison with its lower and higher forms. The field is as yet but little tilled, but enough has been done to suggest this very important question: Do the senses of the lower animals and those of man differ only in degree, or also in kind? Is the sense of smell, e. g., in the dog, merely more acute, or is it not also characteristically different? The latter seems the more probable, when we consider how different the hearing of man is in some respects (music) from that of other animals, even the dog.

Among wholly unsolved problems ranks the nature of the mental processes by which many different tribes of animals find their way back to the place from which they have been removed when the distances involved are great, and often when they have never traveled, so much as once the way by which they return.

Akin to this, possibly, though perhaps quite different, is the question as to the nature of the faculties by which animals are enabled to migrate. "How a small and tender bird coming from Africa or Spain, after traversing the sea, finds the very same hedge-row in the middle of England, where it made its nest last season, is truly marvelous" (Darwin). We are much in need of more *facts* in regard to the migrations of animals; and it is hoped that the systematic work recently inaugurated by the American Ornithological Association may lead to

useful results in this field. With regard to the so-called "homing instinct," it has been noticed that savage or semi-savage man possesses a power of finding his way in the trackless forest by more accurate observation than that of which the civilized man seems capable. While this throws light upon the case of the lower animals, it does but very inadequately explain it. It may turn out that both of these puzzles are susceptible of simple explanation; but at present they strike me as rather belonging to that class of psychic phenomena the meaning of which can be but inadequately understood by man, owing to his not possessing the requisite faculties or those faculties in sufficiently powerful or acute development. The performances of a Shakespeare and Scott in literature, or a Beethoven in music, to the mass of men, must be but imperfectly understood in any proper sense of *realization*. Probably these sons of genius could have given little account of the "manner of it" themselves. We might hesitate to call such faculties as the above in the lower animals genius, or to acknowledge any kinship; but genius among men is often as limited and as disassociated with general mental power as are certain marvelous faculties in the lower animals. It may be that migration is accomplished by means of some forms of acute sensation, according to which the animal acts more or less blindly. Plainly, no mere restless impulse can account for the performance, though it may initiate it. These and many other problems are before us; and, like most recondite problems, they will require the labors of many, each bringing his little for their solution. But is it not worth while? Man can not live by bread alone. We hunger for completeness in our knowledge and harmony in our philosophy. But, apart from this philosophical satisfaction, it can not but prove for the interests both of man and the lower animals that the latter should be better understood.

Belonging, as most of you do, to the veterinary profession, or, as I should prefer to call it, the profession of comparative medicine, either as students or as practitioners and teachers, the more you comprehend the mental workings and modes of expression of your patients, the more successfully must you arrive at an accurate knowledge of their symptoms, and so be the better prepared to relieve the suffering among them, and in so doing also advance man's material interests. To you, at the present time, must we especially look for diffusing more enlightened and humane views, views worthy of this renowned school of comparative medicine, which many of you have come so far to attend. It will be for you to intervene in cases of public panic like that witnessed in connection with the recent hydrophobia scare; reassure the public mind, and protect our fellow-creatures of the lower ranks from needless molestation. There is probably no class of men whose daily life-work gives them so large an opportunity for at the same time acquiring and diffusing truer views in regard to the lower animals. Your enthusiasm and success during the first year of our existence as

a society, have been a matter of equal surprise and delight to me, especially considering how fully you are occupied with the ordinary duties of your profession. We hope to enlist the interest of others and bring them into our ranks, to accumulate a library of books bearing on this subject, secure a large number of correspondents from widely separated parts of the continent, and in various other ways stimulate the study which we feel calls for and is worthy of man's earnest attention.* I can not close this address without making grateful reference on behalf of this society to the kind manner in which, in many ways, Principal McEachran, and the professors of the Veterinary College, have lent their support to our projects.

THE GIANT BIRDS OF NEW ZEALAND.

By HORATIO HALE.

THE discovery of the Dinornis by the illustrious zoölogist, Richard Owen, is famous as one of the most notable feats in the history of science. From a single imperfect bone, a femur broken at both ends, he deduced the fact that an enormous bird of the Struthious order, but far exceeding the ostrich in size, formerly inhabited New Zealand. This discovery, published in 1839, aroused much interest, and led to further inquiry. Four years later, Owen was able to show, from the comparison of many fragments of skeletons which had reached him, that there had been at least six species of these gigantic birds. With additional materials, in 1850, he had increased the number of species to eleven, classed in three genera, and varying in size from a kind no larger than the great bustard (or about five feet high) to one—the Dinornis giganteus—at least ten feet in height. Still later researches have shown that even this stature was in some instances surpassed, and that birds must have existed in New Zealand whose height attained fourteen feet, or twice that of the largest ostrich.

When Owen's first paper on this subject was published, the only white residents in New Zealand were a few missionaries and traders. Since then it has become one of the most flourishing of British colonies, especially distinguished for the educated intelligence of its people. Several scientific associations exist among them, whose members pursue with zeal their researches into the natural history of their

* This young society, so far as known, the only one in America for the study of comparative psychology, is composed at present almost entirely of the students and teachers of the School of Comparative (Veterinary) Medicine in Montreal, though its membership is open to all eligible persons. On behalf of the society, the president takes this opportunity of soliciting written accounts of accurate personal observations bearing on the subject, especially on any of the obscure problems treated in this paper.

islands. These huge extinct birds were, of course, among the first subjects of investigation; and soon a decided and very remarkable difference of opinion appeared. It was known from the first that the native inhabitants were accustomed to speak of these birds under the designation of *moa*, the name that in the other islands of Polynesia, from the Navigator group to Hawaii, was applied to the common domestic fowl, which was not known in New Zealand. The first inquirers, including Owen's missionary correspondents, had assumed, as a matter of course, that the Dinornis had existed in very recent times, and perhaps was not even yet extinct. But a class of skeptical investigators arose, who took a very different view. The leader of this school was Mr. (now Sir Julius) Haast, a distinguished geologist and naturalist, the author of a valuable work on the "Geology of the Provinces of Canterbury and Westland," and of many other treatises, in which, admitting the coexistence of man and the moas at a very remote period, answering to our prehistoric time—as man and the mammoth are known to have existed together in Europe—he denies that the present race of Maoris had ever known those great birds. In his view these creatures represented in New Zealand the gigantic quadrupeds which inhabited the northern hemisphere during the Postpliocene or Quaternary period. If any of them survived that epoch, they had become extinct at an early day, and long before the ancestors of the modern Maoris had found their way to New Zealand.

Mr. Haast's view had in itself a certain plausibility, and it was maintained by himself and his followers with much firmness against many objectors, who brought forward a strong array of facts on the opposite side. The controversy has at length drawn the attention of one of the most eminent of European zoölogists, Professor de Quatrefages. In an elaborate and very interesting paper on "Moas and Moa-Hunters," which has recently appeared, he sums up the controversy with judicial thoroughness, reviewing carefully all the published data, from the time of Owen to the latest contribution to the "Transactions of the New Zealand Institute," and comes to the conclusion that the earlier inquirers were right, and that Mr. Haast's view, in the form in which he proposes it, can not be sustained.* Indeed, the mere facts themselves, as they are set forth in this admirably lucid exposition, are overwhelming in their force, while the scientific skill with which they are marshalled, and the wealth of illustration which enforces the conclusions, are such as might be expected from the accomplished author.

He shows that many eggs and fragments of eggs of the moas have been discovered; that many feathers belonging to different species of these birds and to various parts of the body have been gathered in different places; and that even portions of the skeleton have been found which had muscles, tendons, and pieces of skin still adhering,

* "Les Moas et les Chasseurs de Moas," par M. A. de Quatrefages, pp. 43.

with some feathers, all in a remarkable state of preservation. Nor were these preserved in ice, like the Siberian mammoth; they had simply been dried in the sand, and the bones had not been in the slightest degree mineralized. Further, the traditions of the natives about these birds are perfectly clear. They describe their size, their shape, their habits, and the manner in which they were hunted. The native proverbs refer to them. It was the habit of the male and female of these birds to go constantly together, and the Maoris speak of fighting "two against two, like the moas." They had a particular kind of obsidian knife, which they used in cutting up these birds at their feasts. The prayers or incantations which they were accustomed to recite before setting out on a moa-hunt are still remembered. Such a hunt was a serious undertaking, for the monstrous game could crush a man with one blow of the foot. The very paths which were made by the birds through the mountain thickets, and beside which the hunters were accustomed to lie in wait for them, can still be plainly traced. Furthermore, Mr. J. W. Hamilton published, in 1875, in the "Transactions of the New Zealand Institute," his notes of a conversation held in 1844 with an aged Maori, who, as he remembered Cook, must have been then more than seventy-five years old. He had seen a moa, and described it with all the minute precision of personal knowledge. Finally, if these statements should be questioned, we have the decisive fact that the remains of the great feasts of the natives, which have been found in several places, show the bones of the moa mingled with those of the native dog. Now, the New Zealand dog is the Polynesian variety, used only for food; and the traditions of the natives are quite clear as to the fact that their ancestors, when they came to the country some four or five centuries ago, brought the dog with them.

M. de Quatrefages shows, however, that Mr. Haast's opinions have some foundation, though not precisely in the sense intended by him. Of the eleven species of moa, one, and this the largest of all, the Dinornis giganteus, seems to have been extinct before the advent of the Maoris. At least this is the inference which may be drawn from the fact that none of the bones of this species have been found among the remains of their feasts. Of the next in size, the Dinornis robustus, which was but slightly less in stature, the remains have only once been found in this position; and those of the huge Palapteryx ingens have been thus discovered in only three instances. It would seem, therefore, that the largest of these creatures were either extinct or dying out when man appeared on the scene; but this appearance, it must be remembered, was a very recent event. The result is, that Mr. Haast's view can only be sustained by reforming his geologic chronology, or rather nomenclature—at least, for New Zealand—and bringing the Post-pliocene era down to our own times. And this conclusion suggests a consideration of much larger import. If so good a

geologist as Mr. Haast has been at fault in regard to the antiquity of the moa, may not other able geologists, who have supposed that the mammoth, the cave-bear, and other extinct animals—the contemporaries of the Cro-Magnon artists who depicted them with such life-like exactness—died out at a period long prior to the historic era, be equally mistaken? There seems no more reason for doubting that the last surviving Elephas primigenius may have been killed by some bold hunters of the Cro-Magnon race, in the time of one of the early Pharaohs, than there is for questioning the fact that the last Dinornis was killed by the Maori hunters in the reign of George III.

GENIUS AND MENTAL DISEASE.

By WILLIAM G. STEVENSON, M. D.

IT were comparatively an easy task to explain psychological phenomena by asserting, as did the metaphysicians of the past, and as some do even at the present, that the human brain—the physical sanctuary of thought—is merely an instrument through which various spiritual beings operate, producing at one time the prophetic utterances of the seer, at another time the gifted words of genius, and yet again the extravagant and discordant expressions of madness. This was the "working hypothesis" of Pagan antiquity in its efforts to explain the utterances of its oracles, and also of the Christian fathers in their attempts to explain the inspiration of the prophets and of the apostles.

Greek supernaturalism and the Christian doctrine of inspiration here found a common point of agreement, for both implied a "divine intoxication"—an "overflowing of the mind"—because of its entire possession by a divine influence, which, according as it was good or evil, excited a "poetic furor" indicative of genius, or caused a wild frenzy which was known as madness.

Genius, therefore, was simply a reflection, through the human brain, of an outside divinity of good; while insanity was merely an expression of satanic possession—an inspiration of an evil spirit—and in nature was closely allied to genius.

This belief, although somewhat modified by filtering through ages of changing thought, has been superseded only in very recent times by the conceptions which reflect the broader generalizations of inductive science. From the data thus furnished comes the conviction that mental phenomena "are dependent upon the properties and molecular activities of nerve-tissue," and that there is a "bond of union" between psychical expressions and a nervous mechanism, although the nature of this union is unknown. The facts of consciousness are marshaled before us with all the force of attested verities, but are yet veiled with all the mystery of a passing dream.

The quality of mind known as genius involves, in connection with the reasoning faculties, the special exercise of imagination in its higher creative or constructive forms; and in understanding this faculty we have an insight into the marvelous nature of genius.

It may be said that imagination is that faculty which, in its lower or constructive form, works within the limits of recollection, and transforms the materials of sense-experience into pictures of thought, and recombines them into forms of greater beauty and usefulness, while in its higher or creative form it distills therefrom truths which reason has not yet discerned, and idealizes beauties and excellences which excite our admiration and exalt our emotions.

When thought symbolizes to the mind "the forms of things unknown," it is because the imagination—leaping beyond the bounds of sensory perception—gathers from the infinitudes of unrevealed realities new truths, and thereby "gives to airy nothing, a local habitation and a name." It is thus that the intellect is able to extend the horizon of knowledge, and obtain material for the workshops of the brain.

Imagination, however bold may be its flight, is, nevertheless, under the restraining influence of reason, and performs its wondrous work along true parallels of thought. Its ideals are not mere symbols of myths and fleeting shadows, but ideals which are the embodiments of eternal truths. Thus, by its sovereignty in realms where Ariadne's thread is lost from view, the imagination constructs its empire, and gives by its own methods new revelations of truth, thereby "converting all nature into the rhetoric of thought."

This, then, is the special mind-quality—the "vision and the faculty divine"—which constitutes the power of genius.

In the attempt, not to define genius, but to explain the order of its succession, Mr. Galton was led to "conclude that each generation has enormous power over the natural gifts of those that follow," and that native endowments of mind are of themselves quite sufficient to enable an individual to become "eminent" or even "illustrious."

That there is a profound principle of truth involved in the question of heredity can not be denied, and that the factor of inheritance is the most essential of any which enters into the complex equation of mind as well as of body, is a well-established fact; but it is not the only factor which determines mental expression, nor can a complete classification of known facts be made from it alone. Heredity explains the existence of a general nervous constitution, a brain-fiber, having definite aptitudes or "organic dispositions," which are transmitted from parent to offspring, securing thereby not only a continuity, but a conservation of psychical as well as of physical properties; but the special way in which this mental aptitude shall show itself is largely dependent upon external influences or an unexplained spontaneity.

Organization limits the influence exerted by environment, while

environment limits and modifies the development of the capacities of the organization.

The explanation of genius through the operation of the biologic law of heredity is very satisfactory so long as antecedent and sequence bear to each other definite and ascertainable relations; but trouble begins when the genetic record fails in its apparent unity—as when genius and mediocrity have kinship.

Whence came the genius of Phidias, which enabled him with such immortal art to create in carved ivory and fretted gold the Lemnian statue of the Parthenon and the Zeus of Olympia; whence came the power of Michael Angelo, Salvator Rosa, Leonardo da Vinci, and Rubens, to paint in matchless beauty, on canvas and in fresco, the wondrous imagery of their minds; or of Beethoven, to record in his symphonies the raptures of his soul; or of Scott, to clothe with the habiliments of life the ideals of his brain; or of Spenser, Burns, and Byron, to write with such rhythmic beauty; or of Goethe, to garnish with poetic dress the deep philosophy of his thought? In what cloudland of the past were hidden the possibilities of Dante and Milton, who made their visions of the eternal realms the subject of impassioned verse—at once gorgeous in its rich tracery of thought, and sublime in its pageantry of bliss and woe? In what ancestral brain did sleep the transcendent genius of Shakespeare that read every page "in Nature's infinite book of secrecy"; or did smolder the giant intellect of Newton, which weighed the planets and bound with the force of gravity atoms and worlds in a bond of unity?

Such examples seem indicative of conditions powerful to modify, transform, or deflect the action of the laws of heredity, and to cause "indefinite variability" in psychological phenomena, as is done in material forms. This variability, this new psychic manifestation, is robed with the insignia of a new creation; a new species has been born into the realm of mind, displaying new and more exalted powers, but nevertheless restrained in its action by the organization which, under law, presides with such tyranny over every mental expression, and makes us, to a greater extent than we commonly think, creatures of an inexorable destiny. The contrast between the exalted ideals and grand achievements of genius, and the feeble, discordant expressions of madness, is as pathetic as it is striking. The citadel of thought has been despoiled of its most precious adornment, and in the place where once the Muses sat, mocking echoes now hold carnival, and "melancholy sits on brood."

To give a definition of insanity which shall prove acceptable to medical psychology and to practical jurisprudence, is a more difficult task than it may appear. This is because of the differences in the appreciation of causes and effects in mental phenomena which exist between minds trained in the technical details of physiological and pathological knowledge, and those who witness merely a few of the

more pronounced expressions of lunacy, but are unable to trace the expressions to their relating causes.

To have even a moderate understanding of insanity, it is necessary to clearly comprehend the nature and import of "illusion," "hallucination," and "delusion"—which, when they exist, are of so much importance that some would fain have us believe that the possession of any one of these symptoms is sufficient to make genius and insanity "a little more than kin, and less than kind."

When a person sees, hears, smells, tastes, or feels an object, but perceives it to be what it is not—as when a tree becomes a man, and the murmuring wind his voice—an illusion exists; a real sense-impression is wrongly interpreted by the perceptive centers, and hence the perception does not correspond with the external object.

Hallucination originates within the brain, and is the perception of that which has no real existence; indeed, so purely subjective is it, that the senses have no agency in its production. Under conditions of concentrated attention, ideas, feelings, and sense-perceptions, are marshaled into consciousness with as great distinctness as if they were the products of external objects, rather than that of subjective conditions alone. This comes from the fact that the sense-centers are influenced by impressions received independent of their source. Its function is to transform impressions into conscious sensations, and hence an idea or emotion, when directed in a special way with persistent, concentrated force, may so impress the sensorium as to cause it to project into consciousness sensations which seem to come from objects in the external world. I can not tell how this is done, neither can I tell how it is done when impressions come from without. The facts we know, but the secrets of transformation elude us. The brain constructs new forms, but conceals the methods of imagination by the shadow of unconsciousness.

Ajax becomes enraged because the arms of Achilles are given to Ulysses, and in his wrath he sees animals as Greeks and assails them as if Ulysses and Agamemnon themselves were before him. Talma intensified his emotions and his dramatic effect by the illusive specters of his mind. Spinoza beheld with great distinctness the disagreeable image of his dream a long time after sleep was gone; and Niebuhr, when describing the scenes of his travels, would see all rise before him in "all the coloring, animation, and splendor of Nature." Multitudes have been at times subject to the same false perceptions; as when the soldiers under Constantine saw the cross in the sky bearing the inscribed words, "*In hoc signo vinces*"; or when the army at the battle of Antioch, excited and superstitious, saw the saints—George, Demetrius, and Theodosius—descending through the clouds of heaven to their support.

The consummate skill of Shakespeare in portraying the different phases of false perception, and his power of psychological analysis, are

wonderfully illustrated in the dagger-scene of "Macbeth." Intent on murder, with "courage screwed to the sticking-place," Macbeth is about to enter the king's chamber, when he is startled and dismayed by an apparition of a bloody dagger in the air. For a moment he questions the reliability of his sight, and exclaims:

> "Is this a dagger which I see before me,
> The handle towards my hand?"

He can not believe the testimony of his eyes, and therefore seeks confirmation in the sense of touch:

> ". . . Come, let me clutch thee:
> I have thee not, and yet I see thee still."

Failing to grasp the dagger, he wonderingly asks:

> "Art thou not, fatal vision, sensible
> To feeling as to sight?"

And then, as if reason were struggling to gain supremacy over the senses, he continues:

> ". . . or art thou but
> A dagger of the mind, a false creation
> Proceeding from a heat-oppressèd brain?"

How suggestive, how replete with truth was this prophetic utterance; and yet the intensity of his mind's tension—because of the deed to be done and the vision of the instrument for its execution—still makes the terrible idea the dominating factor of his mind, and subordinates the senses to its rule! He is not yet able to entirely dispel the hallucination, and he compares the apparition to the trusted blade at his side:

> "I see thee yet, in form as palpable
> As this which now I draw. . . . I see thee still,
> And on thy blade and dudgeon gouts of blood
> Which was not so before!"

And then, as if the blood upon the dagger had, by its horrid suggestiveness, steadied his brain, Reason once more resumes her seat and denies the apparition, by asserting—

> ". . . There's no such thing;
> It is the bloody business which informs
> Thus to mine eyes."

These false perceptions, these illusions and hallucinations, while they do not necessarily indicate any mental unsoundness, have been, however, the fruitful source of those apparitions, whether of demons, fairies, or ghosts, which have added to the credulity of man, intensified his superstitions, and made possible the organization of human error under such forms of belief as are typically illustrated by witchcraft and spiritualism.

So long as an individual is conscious that the illusions and hallu-

cinations of his senses are unreal—merely "such stuff as dreams are made of"—the intellect is not affected; but when the false perceptions are accepted as realities, the mind itself is then involved, and a delusion or a false belief is said to exist.

A delusion may be based upon false perceptions; faulty ideas from perverted reasoning about real events, or from mental inability to distinguish differences in things.

A false belief is not, however, of itself indicative of insanity, so long as it is in harmony with the individual's common mode of thought and with the spirit of the age. This is apparent when it is remembered that witchcraft—now regarded as a delusion—was, not long since, held to be a truth; indeed, such master-minds as Bacon, Jewel, Luther, Calvin, Wesley, Blackstone, Coke, and Dr. Johnson, in accepting as a truth that which we now know was a mental epidemic of error, reflected only the universal belief of the age, and were free of any taint of insanity.

That the standard of mental health is variable because it is conditioned by race, age, environment, and circumstances, is abundantly attested by the history of the past; and this fact should be recalled in discussing the kinship of genius and madness.

The popular literature relating to genius and insanity is so meager and fragmentary that the recent contributions by Mr. Sully, on "Insanity and Genius" and "Genius and Precocity," and by Miss Sanborn, on the "Vanity and Insanity of Genius," are as welcome as they are interesting. It is obvious, however, that names are often used to show the kinship between insanity and genius which do not represent the most illustrious minds. Mr. Sully is, however, logically correct in thus using names, for he includes under the term genius "all varieties of originative power, whether in art, science, or in practical affairs"; but in so doing he destroys, it seems to me, the value of his argument in support of the relationship of insanity and genius, for, measured by this standard, the evidence is overwhelmingly against the theory. Neither is due regard given to the real significance of false perceptions, which are often made to appear indicative of insanity, when in reality mental integrity is not impaired.

Although obliged to follow a common trend of thought with familiar illustrations, it is, nevertheless, my hope to place a few garlands of honor on the brow of Health, and to defend genius against the implication that it exists only with madness. The profound ignorance of the ancient philosophers concerning the nature of mind itself justifies us in attaching but little importance to their interpretation of its phenomena.

Thus, Plato's "Psychology" affirmed a self-existent, self-moving, and eternal soul, in form "like a pair of winged steeds. . . . In divine souls both steeds are good, in human souls one is bad. . . . Before entering the body the wings are lost which were nourished by beauty,

wisdom, goodness, and all that is divine. . . . The mind of the philosopher alone has wings; he is ever initiated into perfect mysteries, and his soul alone becomes complete. But the vulgar deem him mad and rebuke him; they do not see that he is inspired. This divine madness is kindled through the renewed vision of beauty. . . . Love itself is madness."

The soothsayers, or diviners, to whom Plato ascribed the "nobler madness," were regarded mad, not only because of their wisdom, but because of their extravagant rage and noisy behavior.

Virgil describes the inspired priestess as full of enthusiastic rage, and fiercely raving in her struggle to disburden her soul of the influence of the mighty god. Indeed, raging, foaming, and yelling, accompanied with antic motions, was the usual way of expressing the influence of inspiration or "possession."

Since Aristotle held psychological views similar to those of Plato, his saying that "it is the essence of a great poet to be mad" adds nothing to the strength of the theory.

The "madness," referred to in the conversation between Horace and Damasippus, did not specially relate to intellectual conditions, or to what we know as insanity, as has been intimated, but rather to individual and social ethics. The "Satire" says: "The school and sect of Chrysippus deem every man mad whom vicious folly or whomsoever the ignorance of any truth drives blindly on. This definition takes in whole nations; this even great kings; the wise man alone being excepted. . . . Whoever is afflicted with evil ambition or the love of money; whoever is smitten with luxury, or gloomy superstition, or any other disease of the mind, . . . come near me, in order, while I convince you that you are mad. . . . Whoever shall form images foreign from truth, and be confused in the tumult of impiety, will always be reckoned disturbed in mind; . . . where there is foolish depravity, there will be the height of madness. He who is wicked will be frantic too."

I confess that, with such statements before us, it hardly seems necessary to discuss the value of ancient opinions on a subject which must be treated under the restrictions of modern definitions. We will, therefore, examine the question from the standpoint of more modern times, when the supernatural agency in insanity gives place to the deteriorating influences which unite it to other forms of nervous disease; and genius becomes a product of an age, in the expansive growth of the human mind.

That these extreme forms of mental expression are often associated, there is no doubt; and that genius is, at times, shadowed by mental disease is a fact well known; but our interest centers in the inquiry, whether this relationship is such an essential one as to justify Dryden in asserting—

> "Great wits are sure to madness near allied,
> And thin partitions do their bounds divide."

Or Shakespeare, when he says:

> "The lunatic, the lover, and the poet
> Are of imagination all compact."

In support of this essential union, Montaigne, Diderot, Pascal, Lamartine, and others, have subscribed their names, but in terms more general than specific, and with more rhetorical beauty than philosophic strength; while Moreau boldly affirms that genius is a nervous disease.

Charles Lamb, himself at times oppressed with mental gloom, stands almost alone in defense of "the sanity of true genius." With this view I am in accord, and, that the justification of this position may be seen, I desire to review the facts commonly cited against it.

Sophocles—poet, statesman, commander—was obliged to make a defense against the charge of insanity, instituted by ungrateful and avaricious children. He answered by reciting the tragedy of "Œdipus at Colonos," which he had just finished, and he then asked the judges if the author of such a work could be regarded as mad. The reply was, "No!" and he was acquitted.

Lucretius—"writer of the purest Latin, and author of 'De Rerum Natura,' the most exalted poem of the age"—whose mind combined the "contemplative enthusiasm of a philosopher, the earnest purpose of a reformer and moral teacher, and the profound pathos and sense of beauty of a great poet," has been used to illustrate the kinship of genius and madness upon the unreliable evidence that he lost his reason from the effect of a "love-philter" (a very ridiculous absurdity) which had been given to him; and after writing several books, during his lucid intervals, he committed suicide.

Were this allegation true, it could only show the baneful effect of a drug upon his brain, which is quite apart from the influence of any psychic cause. The historic facts are too few and insufficient to justify any statement as to the life and personal character of this man, who exerted such an influence over others by his writings, and yet, like Homer, was content to let his personality "pass through life unnoticed." Cæsar, Catullus, and Cicero were his contemporaries, and yet we know of him only through a brief record given by Jerome four hundred years after the poet's death. Independent of the historic doubts as to his insanity, the theory which makes a drug its potent cause, should at least find reason for not uniting to it his genius.

That Socrates had his "demon," or guardian angel, may be true; but, if so, the hallucination corresponded with the accepted belief of the age, and therefore signifies nothing against his mental integrity.

Neither is there justification in using such illustrious names as Descartes, Newton, and Goethe, to prove that madness holds its court so near the temple of greatness.

It is true that Descartes, in an hour of deep intellectual abstrac-

tion, was "filled with enthusiasm, and discovered the foundations of a marvelous science"; and, it may be that, during his profound meditations, in which he "turned the eye of reason inward upon itself, and tried to measure the value of his own beliefs," an idea became so dominant that the sense of hearing responded to its impression, as if a voice from without had called him "to pursue the truth." In no way, however, did this simple and momentary hallucination interrupt the great work of his life, and in no lawful way can it be interpreted as an expression of a morbid mind.

That Goethe once saw his own counterpart approach him I doubt not, but that this false perception, this passing incongruity—a mere incident of poetic revery when the mind, self-absorbed, wandered in its fancy—should be classed as evidence of a pathological condition, and made to bear witness against the healthfulness of Goethe's mind, is an assumption extravagant and absurd.

That Newton was once "decidedly insane," as some allege, is doubtful; and that he ever suffered from any mental disturbance which justifies the inference that his genius was allied to madness, I hesitate not to deny. Mr. Sully says, "The story of Newton's madness, which is given by a French biographer, and which is ably refuted by Sir David Brewster, may owe much of its piquancy to what may be called the unconscious inventiveness of prejudice."

The facts, as I gather them, point to a congestion of the brain—which culminated in a brain-fever—the result of overwork under unfavorable hygienic conditions. Newton himself refers to his illness in a letter to Mr. Pepys, and again in a letter to Locke, wherein he mentions his loss of memory, and his sleepless nights. It is not strange that his illness should excite the fears of his friends, not only for his physical but for his future mental health. Mr. Pepys expressed his anxiety to Mr. Millington, who replied that he had recently seen Newton, who was then well, and that, although his illness had caused "some small degree of melancholy, there is no reason to suspect it hath at all touched his understanding." Huygens, a contemporary scientist, says, in a letter to Leibnitz in 1694, that Newton was ill for about eighteen months with phrenitis or brain-fever, from which he recovered by the use of medicines. With these data before us, it is a misconception of physiological and pathological facts to assert that Newton was insane; and that there was a kinship between his mighty genius and madness, is contradicted by the intellectual work which has given immortality to his name.

The star seen by Napoleon, which was to him an omen of success; the vision which came to Cromwell, and spoke the words prophetic of his greatness; the apparition which uttered the ominous words to Brutus—"I am thy evil genius, thou wilt meet me at Phillipi!" the dreams and visions of Benvenuto Cellini; the "trees like men walking," as seen by Sir Joshua Reynolds, and the appearance of the devil

to Luther—are all examples of hallucinations which are entirely consistent with reason, and are not justly indicative of insanity or mental disease. They represent a habit of mind which naturally, under conditions of concentrated attention, intensified in an age tolerant of all forms of superstitions, "seeks for and creates, if need be, with or without consciousness, an outward object as the cause of its feelings." Luther, for example, saw with his "mind's eye" the image of the devil, which, in that age of religious excitement and credulity, was ever expectant in all minds, and generally present everywhere. "Hallucinations were," says De Boismont, "in the whole social community, not in individuals"; and hence it was that under the dominion of a general belief, however vague or irrational it may have been, the individual mind "demanded of imagination the realization of the phantasms of its dreams; and imagination, despite of the resistance of reason, endowed them with form and substance." Herein is found a distinguishing factor "between real insanity and the separate phenomena of genius and moral exaltation."

In further support of this opinion we may cite the hallucinations of Loyola, when he heard celestial voices; of Edward Irving, who received the gift of prophecy and the "power of tongues"; of Dr. Johnson, when the voice of his dead mother came to him; of Malebranche, when the deep feelings of his soul were to him the audible voice of Deity, and of Joan of Arc, who, under the guidance of saints, led the French arms to victory.

That genius "has its roots in a nervous organization of exceptional delicacy," is undoubtedly true, but it does not necessarily follow that the liability to mental discord and confusion is thereby increased, because this delicacy of brain-structure and its functions are admirably adjusted, and the very perfection of the mechanism enables it to work with the least possible friction or injury.

Under certain conditions, however, we have eccentricities of thought, feeling, and action, which indicate an unstable condition of nerve-element; but it does not follow that this instability necessarily impairs the integrity of the mind; much less does it imply that "genius," more than the lower expressions of mental power, is nearer the border-land of mental disease. I doubt not that permutations of this unstable condition may occur which, by supplementing the natural gifts of mind, cause a variety of individual traits. It may give to the poet Campbell indecision and indolence; make Carlyle cross and pessimistic; Byron proud, generous, and reckless; Schlegel foppish in his vanity; Keats despondent; Pope crafty and pretentious; Swift satirical, avaricious, and irascible; Chateaubriand egotistic and vain; Burns and Poe convivial and intemperate; Eliot sensitive and dependent; Hawthorne shy and modest; Wordsworth simple-hearted yet full of conceit; and Ampère absent-minded and unpractical. Thus might I show certain peculiarities which belong to

the personal mental outfit of almost every one whose individuality is sufficiently marked to make him worthy of notice; but these peculiarities or eccentricities are not essentially morbid, neither do they give affirmative evidence that genius is related to madness. Such peculiarities belong to all orders of mind—the humble as well as the exalted—and can not, therefore, have an exclusive application.

Add to the personal eccentricities of Pope, Byron, Johnson, Carlyle, and Swift the temper which at times became in them extravagant rage, and the proof is yet no stronger that genius and insanity are but different types of mental disease; for passion and appetite are, in all their forms, expressions of organic life and common to humanity, and therefore, as universal factors, they can not be dissociated and made to bear witness either for or against the subject before us. It has already been admitted that eccentricities of character imply a want of mental poise or equilibrium, which is even more apparent in the extravagant passions which at times hold individuals under despotic control, and often indicate decided moral obliquity. This I do not deny, but yet affirm that the violent passion at times observed in one of exalted powers of mind is no more evidence in favor of the kinship between these powers and mental disease, than is the same passion, when displayed in a low and vulgar mind, proof that stupidity is a congener of madness. Mr. Madden is quite as justified in asserting that "the maladies of genius have their main source in dyspepsia," or I in affirming that, because some eminent men have been physically puny and ill-formed, therefore their genius is related to, and dependent upon, bodily imperfections.

In trying to establish the kinship between mental greatness and disease, Mr. Sully states, what I do not deny, that "a number of great men have died from disease of the nerve-centers," naming Pascal, Cuvier, Mendelssohn, Mozart, and Heine—none of whom, however, were insane.

That genius should be subject to "all the ills that flesh is heir to" challenges neither surprise nor dissent; but to hold this as evidence in support of the idea that "the extreme mind is near to extreme madness" is, as it seems to me, an erroneous interpretation of physiological and pathological facts. To prove that Pascal died in convulsions from an acute brain trouble, in connection with a disease of bodily organs, and that Mendelssohn and Rousseau died of apoplexy, and Heine of spinal disease, is not proof that there was any essential weakness or disease of nerve-element, but rather is it evidence of disease of blood-vessels through faulty nutrition. When hæmorrhage occurs in the brain, its substance is disorganized, as it might be if any other foreign substance were forced into it, and nervous disturbance very naturally follows; and possibly secondary nervous or mental disease, but it is not correct to speak of the primary apoplexy as a disease of the brain, or to infer that, because a person of high mental endowments

has thus suffered, therefore, as Lamartine says, "Genius bears within itself a principle of destruction, of death, of madness." Cuvier, after a life of incessant intellectual toil, with mind unclouded, died at the age of sixty-three, from paralysis of the throat and lungs. Kepler, sound in mind, died when sixty years old of fever, which some say caused an abscess in the brain. The cause of Mozart's death is unknown; his sickness was of short duration. He thought himself poisoned, but the facts were hidden in the pauper-grave wherein his body was unkindly thrown. Now, I protest that such cases give no evidence of insane temperament, and in no way illustrate the kinship between mental greatness and disease.

Again, it is said, and often with reason, that this kinship is shown by the suicidal impulse, which "is only another phase of insanity." That suicide or homicide may result, under this impulse, I doubt not, but to make this fact of special value its numerical proportions should at least be such as to make it a factor of constant value. Because Goethe, Chateaubriand, George Sand, and Johnson have said that at times they felt an impulse to commit suicide; because Beethoven, Schumann, and Cowper, who were at times morbid, really made the attempt; and Kleist, Beneke, and Chatterton succeeded in self-destruction—we are not justified in saying that the impulse or the act itself came because genius contains an element of madness. Hundreds who commit suicide every year do not possess genius; why, then, make it the responsible agent for the few?

It is charitable to think that the misdeeds of our friends, or of those whom we admire, are covered by the plea of irresponsibility through insanity. Science, however, deals with facts, not sentiments. That mental and motor impulses often occur which, because they are stronger than volition, regard not the consciousness of right or wrong, there is no doubt; that these impulses are very frequently the product of a morbid mind is also well attested, but the question before us is limited to the relationship which genius bears to suicide, as one expression of madness.

I confess I can see only that relationship which exists in the organic necessities which constitute the foundation of human thought and action, and not the psychological relationship which makes the exaltation of mind the destroyer of its life.

The regularity and constancy of results which spring from the varying conditions of race, climate, and occupations, as well as from the social, political, and moral influences around us, clearly indicate, what statistics prove, that madness is but one of many causes of suicide. Now, since genius is itself exceedingly rare, and its union with insanity still less frequently found, it is evident that suicide, although occasionally committed by those of exalted minds, is altogether too infrequent among them to justify us in claiming it as evidence in behalf of the insanity of genius. Certainly, when we find that Kleist,

Beneke, and Chatterton stand almost alone in this list, the support for the assumption is not strong, nor is it enhanced if the quality of genius thus represented is duly estimated.

Those who would make genius dependent upon or associated with a morbid mental state, seek to strengthen their position by citing the names of Burke, Chatham, Linnæus, Moore, Southey, Scott, Swift, and Shelley, as among those whose faculties were impaired by mental disease. I interpret the facts differently.

It is true that Linnæus at the age of sixty failed in memory, and that, when nearly seventy, an attack of apoplexy ruined his mind; that Moore, Southey, and Scott, when the years of their life were nearly numbered, were enfeebled in mind, because in old age the work of repair had failed; while Swift, at threescore years and ten, lost his mental powers as a result of a disease which began long years before, not in the brain, but in the organ of hearing.

Shelley, indeed, was eccentric and given to sleep-walking and hallucinations, and at times he may have confounded the mythical with the real, seeing "forms more real than living man," but I know of no rule of psychology or of medical jurisprudence which will authorize us to say he was insane. His fervor, his reason, and his imagination conspired to lift him into the higher realms of an idealism which was the antithesis of things as commonly seen, and his mind grew and strengthened until, at the age of thirty years, obedient to the "infinite malice of destiny," he died.

Because Lord Chatham suffered at one time from melancholy, the direct result of suppressed gout, it in no way proves that his genius was allied with madness, for the same clinical facts are observed in all orders of mind.

Since, therefore, every degree of mental disorder from the simplest feeling of depression to the wildest mania, regardless of the quality of mind, may follow from the undue retention in the blood of the waste products of tissue-change, either alone or combined with other morbid bodily conditions, there seems to be but little justification in asserting that "there is no great genius without a mixture of insanity."

In the history of political literature the name of Edmund Burke stands among the first, and is representative not only of that illuminating power which belongs to lofty minds, but of the genius which comes "as the consummation of the faculty of taking pains." Year after year his voice sounded in behalf of the "sacredness of law, the freedom of nations, the justice of rulers," and the imagery of his thought —imposing in its majesty—"carries us into regions of enduring wisdom." For nearly threescore years his mind retained the dignity and calm of lofty greatness, and seemed to totter from its balance only when he breathed the torrid heat of fury which was sweeping over France and gathering wrath against the horrid atrocities of "'89." He had before him the vision of Marie Antoinette, "glittering like the

morning star, full of life and splendor and joy," and felt that, through unbelief and passion, the props of stable government and morals were being broken and destroyed. The "divine right of kings" was yet an article of common faith, and he saw their sorrow, but heard not the wail of anguish which ascended from the oppressed and starving people. Rage against the lawless Parisian mob filled him, and in his wrath he spoke as if envenomed hate had made him mad; and he was so adjudged, but only by those who differed from him. The inspiration of his genius gave him the tongue of truth, and the penalty was an assault upon his sanity.

Then came the supreme sorrow of his life, the death of his son, and in his grief he wrote: "The storm has gone over me, and I lie like one of those old oaks which the late hurricane has scattered about me; I am stripped of my honors; I am torn up by the roots, and lie prostrate on the earth. I am alone, I have none to meet my enemies in the gate; . . . I live in an inverted order. They who ought to have succeeded me have gone before me. They who should have been to me as posterity are in the place of ancestors."

Because of the outward expressions of grief which were at times his, as when his son's favorite horse came to him and put its head upon his bosom, which caused Burke to cry aloud in his sorrow—because of such manifestations of grief, it is said Burke was mad. Edward Everett has well said: "If I were called upon to designate the event or the period in Burke's life that would best sustain a charge of insanity, it would not be when, in a gush of the holiest and purest feeling that ever stirred the human heart, he wept aloud on the neck of his dead son's favorite horse." As proof that his intellect was not disordered, his "Letters on a Regicide Peace," written in 1796, a year before his death, bear ample evidence, and are regarded, says John Morley, "in some respects the most splendid of all his compositions. . . . We hardly know where else to look either in Burke's own writings or elsewhere for such an exhibition of the rhetorical resources of our language."

That Burke had at times eccentricities and fleeting aberrations may be true, but to call such a man insane, or to speak of him as illustrative of the kinship between genius and madness, is to make sport of facts and mockery of human thought.

Notwithstanding the many names I thus take from the roll-call of madness, there are, nevertheless, many gifted minds that have not been absolved from this sad heritage, or been able to bear with calm serenity the misfortunes and burdens of a weary life. Such was Schumann, the eminent composer of music; and Blake, to whom the realities of the world were but dissolving forms of his own consciousness; and Clare, who, when his melancholy was deepened by the neglect of family and friends, wrote so plaintively of his own gloom and loneliness. Cowper was timid and morbid, and agonized under religious

melancholy and suicidal impulse. The insane temperament was also definitely marked in Comte, the oracle of the "Positive Philosophy"; in Tasso, whose melancholy fate gave to Goethe the opportunity to picture a psychological drama, wherein character is revealed under the glow of "poetic furor," and also, at times, oppressed by morbid fears and delusive visions; in Swedenborg, whose prolific mind teemed with fancies and speculations, contradictions and absurdities, which can only be explained on the theory of a mind diseased; and in Charles Lamb, whose "diluted insanity" cast an enduring shadow over his life.

The facts, as I view them, make me dissent from the theory that a diseased brain is the physical substratum of genius, or that the possession of such exalted mental endowments "carries with it special liabilities to the action of the strong disintegrating forces which environ us." "A large genius," says Dr. Maudsley, "is plainly not in the least akin to madness; but between these widely separated conditions a series of connections is made by persons who stand out from the throng of men by the possession of special talents in particular lines of development; and it is they who, displaying a mixture of madness and genius at the same time, have given rise to the opinion that great wit is allied to madness."

To the extent that a nervous organization makes possible excessive emotional life, or vagaries in thought or action, to this same extent is true genius qualified and limited; for, without calm reason and volitional control, creative imagination is distorted into an irresponsible fancy.

The degree of perfection of any mechanism, whether it be a watch, an engine, a harp, a telescope, or the human brain, is the measure of the quality of the work which can be produced therefrom; and, conversely, the quality of the work is an index of the structural character of the instrument employed.

The better the finish and adjustment of a mechanism in its various parts, the less will be the friction, and the "wear and tear" from constant use; and, although the very delicacy of its adjustment may give a greater susceptibility to disturbing causes, the causes themselves are not inherent but incidental. These facts apply with equal force to that most perfect and complex of all known mechanisms—the human brain, which is energized with the subtile principle of life, and evolves thought, feeling, and will, which, in their noblest and most exalted expressions, are indicative not of disease but of mental health.

Nervous and mental diseases are too common among all classes of people, and orders of intelligence to permit us to think that genius is the special object of their dominion. This idea is rejected, not because it is repugnant, but because it is not sustained by facts when measured by the standard of the highest art, or loftiest thought, or greatest work.

Look at the scores of eminent names within a hundred years, and show therefrom, if possible, the evidence which justifies the statement

that intellectual greatness is "beset with mental and moral infirmity," or that genius is merely an expression of a morbid mind, akin to madness.

Imagination gives to genius—which is the intellectual scout of progress, and the Titan force which organizes the factors of civilization—a realm wherein the soul throbs and burns with the fervor which comes only when a new truth cleaves the darkness and illumines a pathway hitherto unrevealed; and where the clash and turmoil of cerebral action excite the highest pleasure, though at the same time they often weary and exhaust.

In this century, when the fierce blaze of modern thought has filled the world with unparalleled glory, and the inventive genius of man has made the earth a vast workshop of industrial arts, wherein the human brain is "master-workman" over all, how rare is it that the brain-worker feels the oppression of a "mind diseased," except when, like the wage-worker, he frets and worries under the burdens of a weary life, and falls by the wayside because the struggle for existence—keen, sharp, and relentless—has taken from him the inspiration, the strength of hope!

Mental stagnation, personal or domestic sorrow, social inthrallment, religious excitement, crushed hopes, and poverty, are the chief moral causes which contribute so largely to the mental infirmities of man.

In conclusion, I hesitate not to say that the most illustrious names of ancient or modern times—in all departments of human thought or activity—have been, with but few exceptions, loyal to the sovereign rule of sane reason; and the sweep of their imagination has been in curves which rounded in the bright empyrean of truth and beauty.

ANIMAL-PLANTS AND PLANT-ANIMALS.

By Dr. PFUHL.

IF we examine the bright bow of Iris painted on the heavens by the sunbeams that break through the parting storm-clouds, no matter how closely we may scan it, we shall not be able to determine where the colors begin or end. As in this arch the blue gradually passes over into a green, and the green in turn changes insensibly into a yellow, even thus we find, in the countless forms in which Nature delights, the most delicate gradations, the most gradual transitions. *Natura non facit saltus:* this saying of Linné's is realized everywhere in the ever-changeful realm of life.

How difficult a matter it is to decide whether the lung-fish of Brazil and Senegambia belong to the amphibia or to the fishes, which in other instances are known to always breathe by their gills! In the rainless season of the year the swamps, the homes of these animals, dry

out; they then coat themselves with a crust of earth, and are dependent on their lungs for every breath they draw. During the rest of the year they can use either these or their gills.

The close relation between fish and amphibia is established in yet another way by the Caudata, which retains its gills and does not lose them, as do its relatives, the frog and salamander. The olm of the Adelsberg grottoes also belongs to this class; it is an animal of a pale-red color, which spends its existence in subterranean darkness. Its eyes, as is also the case with other animals that live in constant darkness, are not developed, there being no possible use to which they could be put; they are very small, and lie beneath the skin.

A connecting link between the birds and the reptiles is found in the fossil archæopteryx brought to light in the slate-quarries at Solnhofen; the feathers denote a bird, the rest of the body is that of a reptile. The *Ornithorhynchus paradoxus* of Australia serves to connect the feathered tribe with the mammalia. It lives in seclusion in dreary regions on river-banks, and builds its subterranean home in such a manner that one of the two exits is always submerged by the stream. It has four feet, and a broad bill, with horn plates on the edges like that of the duck, and seeks its food like this fowl. At the foot of the male there is a spur corresponding to that of a rooster; between the toes are webs like those of water-fowl. It would hardly seem surprising to find this strange creature, in many respects so like the birds, propagating its kind by eggs; but it is a true mammal, and gives birth to live young.

The transition from the palms of the tropics to the palms of the north—the fir-trees—is made by the shining cycadees, whose leaves, as emblems of peace, are placed on tombs. The guetacea must also be regarded as intermediate between the lower and the higher orders of plants. To these belongs the curious "welwitschia" of Africa, the thickness of whose stem exceeds by three times the height. During its whole life—over a century in duration—it bears only two, but very large, leaves, fully two metres in length and one metre broad; it is well named "the wonderful."

At first sight the assertion may seem strange, that the dividing line between the animal and the vegetable kingdom is not definite, and that one may sometimes be in a quandary to know whether he is dealing with an animal or a plant. That the rose must be accounted a plant there can be no doubt; and that the gaudy butterfly, coyly hovering above it, must be classed with the animal kingdom, remains unquestioned. But it is by no means so easy a matter to determine the nature of that peculiar being which we find in damp moss. It is a slimy mass, but little colored; it moves slowly and in every direction, yet no feet are discernible. After a long dispute the botanists have had to accept into their realm these slime-fungi, for during a part of their existence they are distinctively plants, and propagate by spores.

Since the oldest times attempts have been made to find some features characteristic respectively of animals and of plants. But all of these criterions, one by one, have had to be abandoned. Finally, Haeckel, of Jena, severed the Gordian knot. He created an intermediate realm to which all is consigned that is not distinctively a plant or an animal. Now, however, the difficulty is only greater than it was before. Formerly the question was, Animal or vegetable kingdom? Now it has become, Animal, protista (for thus Haeckel named this new division), or vegetable kingdom?

This system of classification at least affords us a general view over those organisms which are, as it were, the connecting links between the vegetable and the animal world, between which, at first sight, there seems to be an impassable chasm.

The slime-fungi have before been alluded to; the class of fungi embraces yet other groups that, as animal-plants, call for some notice on our part. Above all must be named the bacteria; in 1853 these organisms were relegated to the vegetable kingdom. In the case of many bacteria, motion can be observed; some move quietly about, others slide and glide to and fro like snakes or eels. A few species are provided with special thread-like filaments for this purpose. Some bacteria, as well as many other kinds of organisms, can withstand—that is to say, survive—considerable heat. There are, for instance, the algæ in the waters of the Carlsbad Sprudel; they attain luxuriant growth at a temperature of 54° C. Other species of this kind live though exposed to the hot vapors (about 65° C.) of Ischia and Liparia. This is all the more remarkable as protoplasm, the albuminoid substance on which the phenomena of life depend, curdles at a much lower temperature.

A similar tenacity of life has been observed also in plants of a higher order. Wheat-kernels, for instance, if they have been previously well dried, lose the property of germinating only at 72° C., barley at 65° C.; if moist, however, they die at a temperature of about 50° C. The seeds of many leguminous plants can not survive a temperature of 35° C. Pouchet, however, has observed that seeds which were found in the unwashed wool of Brazil sheep resisted for four hours the action of boiling water. The hard seed-shells had prevented the entering of the water. Haberlandt in 1863 made experiments with the seeds of eighty-eight different kinds of cultivated plants, and found that some of them could, when in a perfectly dry condition, stand, for forty-eight hours, exposure to a temperature of 100° C.; in some instances, in fact, germination was hastened by the higher temperature. Nor is the power of germination always destroyed by intense cold. This is demonstrated by the fact that, of three hundred wheat-kernels which were left north by the Polaris in 1871, some sixty germinated in 1877.

Let us now turn our attention to a different group of organisms,

before briefly referred to, and which formerly were regarded as belonging to the animal kingdom—some species of algæ.

In 1843 the botanist Unger, while examining certain green plant-fibers under the microscope, suddenly noticed some sphere-like bodies dart out of these fibers and move to and fro in the water, kept in rapid motion through the aid of cilia.

This wonderful sight (for up to this time nothing like it had been observed) surprised him greatly, and he announced his discovery to his collaborators in an essay bearing the title, "The Plant in the Act of Transformation into an Animal."

To the algæ belong those minute organisms that sometimes give to water a bluish-green color, that redden snow, and that change ordinary rain into a rain of "blood." Ehrenberg states that the Red Sea takes its name from the algæ which it sometimes throws far up on its shores. Reports of "blood-rains" are not at all infrequent in the records of the past. Chinese history, written eleven hundred and fifty-four years before the Christian era, makes mention of such a phenomenon; the Bible writers speak of similar occurrences, and Livy also reports an event of this kind.

But only one group of these organisms, the diatoms, will receive our closer attention. They surpass the bacteria in size; still, a good microscope is needed to observe them. Whereas the bacteria present only few, and at that, simple forms, but colors of varied hue, the reverse is true of the diatom family. Their color, when they possess any, is a more or less dark brown or a green, but the delicacy and beauty of their forms is striking. Some look like minute gondolas, others resemble fans, or approach in form an S, a circle, or an ellipse. If a higher magnifying power be employed, most dainty linear tracings will be seen on their shells, for these beings are enveloped in shells which consist chiefly of silica.

Linné's expression, "*Natura in minimis maxima*" (with her smallest agents Nature accomplishes her greatest works), is especially borne out by the diatoms, for they have been active agents in the formation of the crust of our globe; rocks, ocean-beds, in short, entire geological formations, are the results of their labors. The polishing-slate of Bilin consists only of diatoms—one litre containing something like two billions of them. A considerable part of Berlin, the capital of the German Empire, is built upon a bed of diatoms, the uppermost layer of which is still alive.

Thus far we have noticed the power of locomotion—this prime characteristic of animal life—only in the lower orders of plants, the algæ and fungi. Might we not expect to meet with this also in plants of a higher order? Motion, perfectly free and unrestrained, we should here of course seek in vain, but many plants possess the power of moving some of their parts. In this connection we would recall the Mimosa, which, in response to the slightest touch, will imme-

diately fold her leaflets. This same effect is also induced by cold and darkness.

The flowers of many plants are found in certain ways to be greatly dependent on temperature and on light. They open in the morning when the sun has reached a certain place in the heavens, and close again at a stated time at night.

Some plants can open their flowers or parts of them very quickly. For instance, the *Martha* of the tropics, on the approach of an insect, ejects its pollen suddenly, and then as quickly closes the entrance to the flower, and refuses the insect admission. Motion of a different nature is shown by the climbing plants that were so closely studied by Darwin.

At times one hears or reads of the wandering of plants. But how is it possible that firmly rooted plants should be capable of changing their position? And yet this is so. In most cases, it is true, the removals are made merely by the seeds and not by the plant as a whole. Sometimes, however, the whole plant starts out to travel; this is generally accomplished by the friendly aid of the wind. The world-famed Anastatica, the rose of Jericho, comes in for mention here. It has the peculiar property of spreading out its branches, that at other times are folded to a ball, whenever its roots are moistened by water. In its dreary home, the deserts surrounding the Red Sea, it is but slightly fastened in the loose sand. Without much trouble it is torn from its bed by the winds and borne to great distances.

Some species of algæ, which form green or yellowish-green masses on the surface of placid waters, are thrown on the land by inundations, and are kept back after the waters have subsided, and finally dry into a peculiar matted substance not unlike coarse packing-paper. This is taken up by a strong wind and carried away. These wandering masses, which some people have readily connected with superstitious conceptions, are called "meteor paper." The water-pest is another plant that spreads itself in the same manner; as far as can be ascertained, it was transplanted in 1835 from North America to Ireland, and from there to the European Continent.

The majority of plants, however, are spread by the aid of their seeds, which are covered with hair or a fine woolen fiber, and can thus be easily scattered about by the winds, just as some varieties of spiders, in spring and autumn time, clinging to a silken thread, intrust to the winds the choice of their future home.

Let us now turn to a group of plants which claim interest by being possessed of a faculty generally attributed to animals only. Not satisfied with the nourishment which the humidity of the soil and the atmosphere afford, they seek to obtain a kind of food which Nature has, strictly speaking, denied them. I mean the *insect-eating plants*.

The knowledge of the existence of these curious beings is not really of a recent date, but former investigations remained unheeded.

Only after Darwin had made his researches were they recalled, and at once commanded the interest of naturalists to such a degree that, at present, there are known over three hundred plants that feed on insects. They belong to various families, and are found in all parts of the globe. But how can the firmly rooted plant capture and grasp the light-winged insect; how can it retain the same sufficiently long to let the digestive juices act upon it? Naturally, in many cases, the sticky substance which is secreted by the leaves is the active agent, as, for instance, one may observe small animals adhering to the resinous stem of the "flytrap." But many plants are provided with special organs for this purpose, and they are able to catch the most nimble of insects with ease and dispatch.

One of the best known of these insect-eating plants found here, as well as in Lapland and Scandinavia, is the Sun-dew (*Drosera*), discovered about a century ago. Another plant, the so-called *Flytrap of Venus* (*Dionæa*) of America, which was brought to England one hundred and twenty years ago, has received the name of Venus for the reason that, like the goddess of Beauty, it attracts and captivates everything that heedlessly approaches it. At the bottom of the plant the leaves cluster like a rosette; from the center of this arises the flower-stalk. The edge of the leaf, which is nearly circular, is overgrown with strong bristles, while its surface is covered with small glands, at either side of which are three long hairs. A fly approaches; carelessly it settles on the leaf, and perchance touches one of the six long hairs: suddenly the leaf folds, the bristles interlace, and the insect is caught. Oftentimes the whole tragedy takes but ten seconds. The sensitive hairs have performed their duty; now begins the work of the glands. These discharge a large quantity of a colorless acid slime—the digestive fluid, pepsin—and the closed leaf changes at once into a stomachic organ. After a lapse of eight or nine days the leaf reopens, the insect has disappeared, the prey has been consumed. The above-mentioned facts constitute the main features of the process of digestion, but in connection with it many questions arise. What happens, for instance, if a non-edible object irritate the hairs, perhaps a stone or a piece of wood? The leaf closes with the greatest possible swiftness, but soon discovers its mistake, and does not discharge the digestive juice; after a lapse of twenty-four hours it again unfolds, ready for another capture. This does away with the marks of distinction thus far generally accepted, namely, that "plants live, animals live and feel" (*plantæ vivunt, animalia vivunt et sentiunt*), for the Dionæa distinguishes quite readily, by taste and feeling, that which is digestible from that which is not. By experiment, it has been ascertained that nitrogenous nourishment is preferred by the Dionæa; hence every kind of meat (beef, pork, and veal, either raw, fried, or stewed) is digested by the plant; also albumen and cheese; the latter, however, causes disturbances during digestion, and the leaf easily ails. If nourish-

ment be again offered to the same leaf, will it be able to digest a second time? Yes; but the process of digestion is much more tardy, and, if the plant outlive this exertion, it certainly perishes in making a third or fourth attempt. Too large a quantity of food will kill the plant immediately. This property, apparently so startling a one in plants—namely, their being capable of digesting animal food—loses in strangeness if we look about us more carefully in the vegetable kingdom. There we find not unfrequently this power of digesting nitrogenous—i. e., animal substances, or at least of changing them from a solid to a more soluble condition. For instance, the seeds of many plants store up food for the purpose of nourishing the young plant in the beginning of its existence. Albumen, a substance particularly rich in nitrogen, is first changed into soluble material by the young bud, and is then by degrees absorbed, or, in other words, digested. Other plants possess similar dissolving juices, but up to the present it has not been ascertained what advantages the plant derives from their possession.

Five grammes of the milk-juice of the fig, diluted with sixty grammes of water, will dissolve ten grammes of fibrin in twelve hours, and in a month's time can gradually digest as much as ninety grammes. In this respect the "melon-tree" (*Carica papaya*), a small tree of South America, has, above all others, claimed the attention of botanists. A few drops of the milk-juice, which fills all parts of this tree, are said to soften in a short time the meat of even old animals, and if we may credit the tales some travelers tell, it is sufficient to roll the meat up in these leaves for several hours to render it soft and palatable. From the milk-juice of the *Carica* there has been obtained a compact substance called "papaiine," three grammes of which will dissolve one hundred grammes of fibrin in two days, and it has furthermore been found that the action can be made a continuous one.

Let us now leave the domain of plants and enter into that of animals, so much more varied in number and form. We shall still fancy ourselves in the kingdom of flowers when we turn our attention to those variegated beings which cluster about the subaqueous rocks in wild profusion. There seem to be brilliant flower-calyxes of hyacinths, carnations, anemones, gently rocked to and fro by the water—calyxes which, even had they grown under the genial warmth of sunlight, could hardly bloom more beautifully. But should one try to gather a bouquet from among these magic flower-beds, he would scarcely have touched a bud, when a sharp, stinging pain, more disagreeable than the burning of the nettle, would be felt. Even the sea-rose defends itself, and stings; very quickly it sends forth from their resting-place filaments charged with a corrosive fluid, filaments that, until then, had remained spirally incased like a spring wound up and ready for use. And how enormous is the number of these weapons of defense; some individuals are capable of sending forth six thousand millions! In the last century the plant-like nature of these sea-flowers was so generally

accepted that Réaumur, in the Academy of Sciences, did not disclose the name of Peysonnell, a physician of Marseilles, who first declared them to be animals, for fear of his being ridiculed. For what Aristotle, the founder of the descriptive natural sciences, had written more than two thousand years ago, had passed into oblivion.

And how much greater is the resemblance which is borne to plants by those little animals that build the immense coral reefs; which turn again into rock that which the solvent power of the waters had at one time extracted from the cliffs! Very early in the history of the world, these little builders entered into the thoughts of man. Mythology attributed their origin to plants, which were said to have been thus transformed, as is related in the following legend: When Perseus had released the beautiful Andromeda from the terrible monster, he placed the head of the Medusa, whose frightful aspect turned to stone everything that beheld it, on some plants which he had taken from the ocean. But lo! these plants were immediately turned to stone. The water-nymphs soon came to satisfy their curiosity, and to marvel at the wonder. Playfully they scattered the seeds of these stone-plants into the ocean, and behold, the corals were created!

Not unfrequently hidden coral reefs prove a source of great danger to navigation. Two hundred and fifty years ago only thirty coral islands had been located in the strait between New Holland and New Guinea; now they number over one hundred and fifty, and soon, perhaps, this channel will become impassable. But is it not probable that other forces, besides the growth of the corals, are here actively at work? One of the most changeable parts of the globe is the neighborhood of that wonderful island, Australia. Numerous are the islets which there slowly arise from beneath the waters; numerous those which gradually disappear. Darwin was the first to show how sure a proof of geological changes such coral reefs are. The polyps which build them die at a depth of thirty metres, and the contact with the atmosphere is fatal to them. Hence, very deep coral structures denote a sinking, those above the water, on the contrary, an upheaval of the earth's crust.

And as the Jura, a part of the Alps and the Carpathian Mountains, display marks of such animal structures, it is a proof that all those mountain-ranges have, in the past ages, arisen from the ocean. They must have risen from a *warm* ocean, warmer than the climate of those regions is to-day, for the tropics only are the home of the reef-building coral-polyps. And how enormously they multiply under favorable circumstances is shown by the barrier-reef, four hundred miles in length, near the northern shore of Australia. Between it and the mainland there is a channel, over six miles in width, the water of which is calm, and always affords to vessels a refuge from the wildest storms.

And when we turn our gaze on the fauna existing between the

branches of the coral, we behold animated life; a world in itself is spread before us; here dwell most of the various inhabitants of the sea—snails, shells, and sea-urchins, fishes and crabs of the queerest shapes. Here in the domain of color, where everything seems brilliantly attired, they are less easily discovered by their enemies than in the ocean. In fact, one can often observe that the exterior of animals is in accordance with their surroundings. The inhabitants of the desert have a sand-like color; those of the polar regions are of light shade; some caterpillars resemble the twig of a tree; some butterflies look like dried leaves; and a grasshopper has, on account of the shape of its body, received the name of "wandering leaf."

But the beautiful aspect presented by a branch of coral, when under water, immediately vanishes when it is removed from its native element, as the many little arms are then contracted. The skeletons of various species are, however, much sought for as ornaments, above all the black coral of India, which is considered a talisman. Next in value ranks the red coral, found near Algiers, and third in rank comes the white.

Another kind of plant-animals, which build structures like those of the coral, only not so large, not so hard, nor so lasting, are the *sponges*, sea-animals in the strictest sense of the term. The eastern part of the Mediterranean, and the Red Sea particularly, abound in valuable sponge-beds, on rocky soil. Numerous vessels arrive there every summer to collect the crop. Recently the cultivation of artificial sponge-plantations has been tried by taking a piece of fresh sponge, which still contained the slimy bodies of the sponge-animals, and planting the same in a favorable spot. The experiment succeeded admirably.

It seems easy and natural enough to turn our attention from the sponges to *chalk*. This very important writing-material is, as is well known, an accumulation of minute animal remains, or, more correctly speaking, of their calcareous shells. What large deposits they are capable of forming is shown by the chalk-cliffs of Rügen, by those of Great Britain, to which the island owes the name of "Albion" (white), and by those of Crete, from which the German word "Kreide" (chalk) is derived.

The chalk-cliffs arose from the ocean, but their later upheaval is due to volcanic eruption. The minute animals, which form the masses of chalk, are of various shapes; some resemble the houses of snails, some the cone of a pine, others again are staff-like.

The largest of the existing three hundred kinds have been known since the oldest of times, for they were found in the stones used by the builders of the Pyramids. Their incasement is greatly perforated, and from their pores they send forth numerous fine, slimy feet, which constantly fluctuate to and fro. By adhering closely to one another they cover their food-supply, and then gradually assimilate the same.

As the aurora borealis flashes through the darkness of the polar

region, the nights in the tropics are made light by a curious, brilliant phenomenon: particularly bright sparks flash out in the ocean, at places where the waves break over rocky cliffs. Over one hundred kinds of animals may co-operate in producing this magic effect. Among these are the *Salpæ*, the life-history of which Chamisso learned on his voyage around the world. He was the first to prove that the *Salpæ* which cling together in chains do not vary at all from those swimming about singly. Other agents of a phosphorescent sea are the *Medusæ* (sea-nettles)—many-colored animals, possessing the most weird of forms. Some kinds have the shape of a bell; long filaments hang down from the edge, and in the center they have long arms to capture and paralyze their prey; in this they are aided by a number of those nettle-like organs mentioned in connection with the polyps.

Occasionally these queer creatures become visible on the surface, in masses several miles in extent. The material of which the body is composed seems to be chiefly water, as a *medusa*, about twenty pounds in weight, yielded when dried only thirty grammes of gelatinous flakes.

After the ominous sea-serpent, one of the most interesting of the beings which inhabit the mysterious depths of the ocean is Huxley's *Bathybius*, made of nothing but shapeless, motionless slime. It has been supposed to be the common origin of the animal and the vegetable kingdom, from which all beings have gradually been developed. But lately science has become doubtful as to its true properties, and has begun to question its organic nature; many naturalists consider it nothing more than gelatinous gypsum. Another animal, somewhat of this nature, which several years ago crossed the path of science, like a flickering will-o'-the-wisp, is the *Eozoön Canadensis;* gradually it has become more and more deprived of the animal characteristics once ascribed to it, and has been again assigned to the inorganic world.

Many are the errors and pitfalls that mark the path along which ever-searching Science strives onward to truth; and yet even these, in their way, show a triumph gained by the divine power of the human mind over its human failings!—(*Abstracted from Virchow and Holtzendorffer's "Sammlung gemeinverständlicher wissenschaftlicher Vorträge."*)

Professor Edward S. Holden has sketched in "The Overland Monthly" a plan for co-operative photography of the stars. Under ordinarily existing conditions of doing the work, it would take an observatory one hundred and forty years to make a complete photography of the heavens, or ten observatories fourteen years. The desirability of several observatories engaging in the work together is therefore obvious. Photography may be expected to help in the discovery of new asteroids; in the search for the hypothetical planet beyond Neptune; in making star-maps; in finding stars that make no impression on the eye or telescope; in accurately fixing the aspect of the sky, as it is for the benefit of students in all the future and for comparative astronomy; and for many other purposes of practical and scientific importance.

SKETCH OF EDWARD L. YOUMANS.

By HIS SISTER.

EDWARD LIVINGSTON YOUMANS was born at Coeymans, Albany County, New York, June 3, 1821. His parents, Vincent Youmans and Catherine Scofield Youmans, were natives of the same county. Livingston, as he was then called, was the first-born of seven children. When he was six months old the family removed to Greenfield, Saratoga County, within a short distance of Saratoga Springs. His parents were in narrow circumstances, and belonged to the hard-working class. Vincent Youmans had worked on his father's farm when a boy, but, having some mechanical capacity, he resolved to learn a trade, and accordingly, at the age of sixteen, was indentured for five years as an apprentice to a carriage-maker in Sheffield, Massachusetts. He was to be taught the business, and have some schooling. But 'Boss' Burrill was a hard master, and his apprentice got neither the schooling nor any proper instruction in the business. In all the five years, he attended school not more than three months, and seldom on consecutive days, while most of his time was spent in slavish toil on the Burrill farm. The boy felt outraged by this treatment, and showed signs of restiveness, when the wily wagon-maker lost no time in having the indentures revised, making the father liable for damage if the son ran away. Filial affection made Vincent submit to his lot, but he can not speak of this period of his life without indignation. Although his means were limited, yet, feeling deeply his own lack of knowledge, he was full of sympathy with the mental aspirations of his children, and made extreme sacrifices in furtherance of their education. He was, moreover, a clear-headed man, of fearless, independent spirit, who took an earnest and intelligent interest in all public questions. Before her marriage Livingston's mother was a school-teacher. Well endowed in body and mind, her long life has been spent in unwearied devotion to her family, and never had mother a more loving and dutiful son than was the subject of this sketch. She made home duties paramount, but she had opinions of her own, was frank in their avowal and spirited in their defense; and the lively, good-tempered canvassing of differences between father and mother were not lost upon their little ones, who early learned to respect and to defend their own sentiments. Whatever else may be said of it, the family circle was certainly never dull.

Livingston was a vigorous, active-minded boy, remarkable from a very early age for his desire to know, and for his readiness in learning. He took to books from the first, and read everything he could find to read. He was also fond of play, and especially of hunting, when old enough to handle a gun; and he used often to refer, in his

days of blindness, to his clearness of vision at long range when sighting game.

He began going to school at the age of three, and was steadily in his classes for the next half-dozen years. The district school he attended, and the Presbyterian church, of which his parents were members, were of the New England type of that period. The home-spirit was eminently favorable to the growth of individuality, and the nearest household in the neighborhood—where my brother was a great favorite—consisted of very decided characters, well calculated to produce a marked effect on the receptive mind of the boy. It was here that Livingston got his first idea of the classics. When not more than nine years old, he became interested in a copy of Homer's "Iliad," which the eldest son was studying, and which contained a translation as well as the Greek verse. All his teachers at this period—the clergyman of the parish, an uncle just graduated, and the young men preparing for college who were winter teachers of the common school—helped incline him toward the classics. When about twelve years old, he prevailed upon his father, who then owned a little farm, and was going to Albany to market a small surplus of his crop of grain, to buy him some books. The list he prepared, beginning with those most desired, was a long one, but the proceeds of the sale of grain were only sufficient, after other indispensable purchases were made, to secure the first few volumes, among which were translations of Homer's "Iliad" and "Odyssey," Virgil's "Æneid," and Ovid's "Metamorphoses." These were his earliest possessions, and were made the most of; other books were borrowed from neighboring clergymen or from citizens of Saratoga; and a year or two later, with the proceeds of a patch of potatoes, planted by himself for the purpose, joined with a small contribution from his father, he was enabled to buy a "share" in a circulating library recently established in the vicinity. This library contained three or four hundred standard works in history, biography, poetry, and fiction, with a set of the "Encyclopædia Americana"; but of science there was little or nothing, unless Buffon's "Natural History" might be ranked as science. With his fondness for books, no greater trouble could now come upon him than the disease of the eyes which, prevailing in the family during the winter of 1833–'34, attacked him when he was thirteen and a half years old. He could not let books alone long enough to permit a full recovery. Reckless of results, he persisted in reading whenever it was possible, in spite of protests and warnings. From this time until he was seventeen he was troubled with chronic weakness and frequent inflammations of the eyes, and when unable to read himself others read for him. During this period, the vigorous and abundant literature of the anti-slavery movement found its way into the home, his father being one of the earliest abolitionists in that part of the State. In the wide range of its discussions, the religious, ethical,

political, economical, juridical, and ethnical aspects of slavery were treated by the ablest men of the nation. Livingston was familiar with every step of the controversy.

Having been interested in language-studies from early boyhood, he was in the habit, during these years, of practicing literary composition, and was also studying natural philosophy and chemistry in the district school. Despite his eye-trouble, he was still intent upon pursuing a regular course of study, and began his preparation for college in the spring of 1838, at the Galway Academy, under Professor Morgan. In the ensuing autumn he began to teach a common school, but his sight soon failed him, and from this time until he was thirty years old he was practically blind. The next two years were passed in the vain hope that time and rest would bring about a restoration of his vision. He was treated for a while by a local oculist of some reputation, but his eyes grew worse, and his general health became much impaired. This period, however, was not wasted. Much of it was spent in undisturbed reflection. His early habit of thinking for himself was now of great value. His excellent memory was stored with abundant material for thought, and perhaps nothing could have better promoted his solid education than those two years of quiet. But his habit of reading was also kept up; his brothers and sister, who had always been his loyal pupils, and were interested in everything that interested him, became his sympathetic co-workers in the study of any subject he chose. The classics, however, no longer occupied his attention; but he was already manifesting distinct tendencies toward scientific thought. Whatever taste or talent he may have had for experimental science, the state of his eyes prevented its pursuit. His love of science in its useful applications, and his enthusiasm for its popularization, were no doubt fostered by his blindness. Hence, while cut off from all part in the making of science, he was to find a most congenial field of labor in the work of its diffusion.

His eyes growing worse instead of better, in the fall of 1840 he came to New York for treatment in the eye infirmary. He remained there several weeks without improvement, when he was informed that the physician in charge regarded his case as hopeless. He left the institution at once, and visited other oculists in the city. Among these, Dr. Elliot gave him most encouragement, telling him that his eyes were by no means hopelessly ruined, and that he would undertake their cure for a fee of $150, to be paid in advance. The amount was at once obtained from home; and it may be added that this was the last money he would consent to accept from that source, ever after relying upon himself for support. The previous two years of indoor life, with occasional seasons of reducing medical treatment, had seriously impaired his vigor, and he was suffering under a constant liability to take cold on the most trifling exposure. After a few weeks of continuous but slow improvement, he began to see well enough to go

about and help himself a little, and was encouraged to form plans for future work, when suddenly his eyes became again inflamed, and he was thrown back into his old condition of blindness. This state of health continually prevented his complete recovery of sight; and so for the next twelve years he very rarely had vision enough to read ordinary type.

On leaving the infirmary, Livingston boarded for a time in a house with several printers of the more intelligent class. Their society suited his tastes, and they took a strong personal interest in him. They brought the important new books of the day to his attention, and read them to him in the intervals of their work. After a year or two he had the good fortune to be received in a Quaker family, where he was treated quite as one of the household. His New York home continued to be with these excellent people for many years. The Quakers called him by his first name (Edward), as it was easier to speak, and the other was soon dropped, except in his family and among the friends of his youth.

During the early years of his life in New York, Edward sustained himself by literary labor, of a rather miscellaneous character, having devised a writing-machine which could be carried in the pocket, and by the aid of which he was able to work without assistance. In a few months, under Dr. Elliot's treatment, he became sufficiently familiar with its routine to carry it on, with my assistance only; and after this he often came home to Saratoga with a carpet-bag full of books, enough to occupy us for weeks, or until an unmanageable relapse compelled a return to his physician.

It must not be inferred that this self-education was a hap-hazard affair. On the contrary, it was carried out with a definite purpose, and with the utmost perseverance. Of course, all the early plans about going to college were now ended, and quite as much from choice as from necessity. His knowledge of science, and particularly of applied science, had been steadily growing, and he had studied with especial care all the important works on scientific agriculture. It was impossible for him to rest with half-knowledge, but his blindness made the chemical side of this subject especially difficult. This obstacle was partly overcome in the summer of 1843, when I had the advantage of attending a very full course of lectures and experiments in chemistry, given at Fairfield, New York, by Professor Mather. After this we could manage the subject fairly well together; but, unable as he was to observe the characteristic behavior of chemical substances, he could not readily individualize them. His ideas about them, therefore, were easily confused, and he was constantly striving to make them more definite.

In the fall of 1845 I was able to join my brother in New York, and give all my time to his assistance. When not occupied with tasks of immediate concern, he now gave his attention to the execution of a

work already carefully thought out, which should give the synchronous progress of invention, discovery, and learning, from the beginning of recorded history. Many months and a great deal of labor were devoted to research in the various public libraries, and when the undertaking was far advanced toward completion it was forestalled by another work covering substantially the same ground. This was a bitter disappointment, but, wasting no time in regrets, Edward was soon at work on an arithmetic, in which the problems were made up from the constants of science. This enterprise also was anticipated by another book of similar character. But the labor thus bestowed was not wholly lost; for it helped to educate him in the line of his future work.

Although occupied most of the time as above stated, my brother kept up the study of agricultural chemistry, and, to this end, ever since my arrival in the city he had been seeking for a laboratory where I could enter as a pupil; but none was found that would admit a woman, until Dr. Antisell, one of the Irish exiles of 1848, consented to receive me. Here I at once began the studies preliminary to the analysis of soils. By the time I was able to make such analyses, my brother had become convinced that they were of no value in practical agriculture. But, in our talks over this laboratory experience, he was still hindered by the old difficulty of dealing with chemical phenomena at second-hand; and now an unexpected consequence followed. When he reflected that chemistry was fast becoming a popular branch of education, and that, so far as its processes were concerned, the youths who were studying it might be classed, along with himself, as blind, their situation naturally interested him. Occupied with this subject, there one day arose in his mind a scheme for picturing atoms and their combinations that would bring the eye of the student into more effectual service. Out of an impulse to help this unfortunate class came the "Chemical Chart," in which he succeeded in making clear to the eye, and easily remembered, the most important principles and laws of the science as it was then understood. This "Chart" represented the principal elements, binary compounds, and salts, and the minerals of chief interest to geologists and agriculturists, together with the most important organic bodies. Atoms of the different elements were shown by diagrams of different colors, the relative sizes of which expressed their combining ratios, and the compounds exhibited the exact numbers of the respective atoms that unite to form them. The chart was at once accepted as a valuable assistance in teaching chemistry by many leading educators throughout the country, and its use led to frequent requests that its author would prepare a book to go with it. The textbooks consulted in its preparation had left the impression that this science was not so attractively presented to the learner as it might be. He thought that chemistry could be made enticing as well as intelligible to learners who had not the help of experiments in its pursuit.

When asked to make a book himself, however, he did not at first entertain the idea; but the thought grew upon him, and by degrees took definite shape. Acquainting himself with all the standard text-books, and, clearly perceiving what he wished to accomplish, he set about the preparation of the "Class-Book of Chemistry," giving all his time to the work. When it became a question of finding a publisher, preceding events had much to do in deciding his course. He was already indebted to Mr. W. H. Appleton for many kindnesses in the loan of valuable books, and for sympathetic interest in his undertakings. It was, therefore, most natural that the manuscript of his book should first be offered to D. Appleton & Co. Their reader, Mr. Tenney, a stranger to the author and his circumstances, gave the work his unqualified approval, and used afterward to refer to the fact in proof of his good critical judgment. The "Class-Book" appeared in 1851, and its clear, lively style, its brevity, freedom from technicalities, and continual reference to the important practical applications of chemistry, soon made it a favorite with beginners in the science. It has been twice rewritten, and its enduring popularity is shown by the fact that the sale of its three editions has reached the number of 144,000 copies.

The "Chemical Atlas," published in 1854, was an extension of the method employed in the "Chart." The scale of illustration was much reduced, and it contained maps portraying elementary chemistry, the chemistry of geology, homologous series of compounds, nitrogenized and non-nitrogenized principles of food, and giving examples of isomerism, and the theory of compound radicals. The great natural processes of combustion, respiration, fermentation, and the chemistry of light or solar dynamics, were also pictorially presented. The accompanying text was carefully written, and marked by the same qualities of style as the "Class-Book." But all these publications were based upon the binary theory of the composition of matter, and when this gave place to the new chemistry, the "Atlas" and "Chart" were no longer of use, but the "Class-Book" was rewritten.

After the publication of the "Class-Book," Edward's health underwent a marked improvement. He gained in weight, his face became round and ruddy, and at thirty-five he looked much younger than at twenty-five. His countenance gradually lost the introverted expression of the blind, so marked in his portraits between the ages of twenty and thirty, and his eyes became so much stronger that he could now say farewell to the doctor. While his eyes would bear a great deal of use, he was often tempted to overwork them, when they would give out for a time, but by rest and other means they were soon at his service again. He was, however, distressingly near-sighted; so that except his familiar friends, whom he recognized by traits of form or movement, he did not know people unless they were within a foot or two of him. This circumstance was a great bar to his enjoy-

ment of general society. It made him timid and hesitating, and often occasioned awkward and most embarrassing mistakes although he was by nature the most sociable and genial of men, and delighted in society where he felt at ease.

He published a book in 1853 entitled "Alcohol and the Constitution of Man," which grew out of an article of his on the "license system," covering a full page of the "New York Tribune." His argument was based upon the view, put forth by eminent scientists, that alcohol is in all cases a brain-poison. The temperance people urged him to make a book of it, which he accordingly did; but further knowledge of the subject made him uncertain of his ground, and the work was allowed to pass out of print.

In illustration of his dependence upon others at every step of his life, it may be stated that in 1853 a younger brother returned from a four-years' residence in California, and, being unsettled as to his future, was persuaded to undertake the establishment of an experimental farm at Saratoga. But, before matters had taken shape, it became apparent that the young man could not be content with the quiet labors for which there had been neither emotional nor intellectual preparation, and the enterprise was abandoned. Feeling the importance, in the light of this experience, of early scientific culture, Edward did all in his power to promote the scientific education of a much younger brother, who many years later began with him the management of this magazine, and without whose co-operation it would not have been attempted.

In 1856 Edward read in a foreign periodical a review of Herbert Spencer's "Psychology," which had been published the year before; and his interest was so aroused that he at once imported the book. This led to a correspondence with the author concerning the publication in this country in book form of his essays on education, with the result that D. Appleton & Co. brought out the work in 1858. Thus began my brother's acquaintance with Mr. Spencer, and co-operation in the publication of his writings, which was kept up to the end. In 1859 he accidentally got hold of a copy of the English programme of Spencer's "System of Philosophy," which was to be issued in parts to yearly subscribers. Edward immediately wrote to Mr. Spencer, volunteering to aid the project in this country, and was informed that it would require two hundred and fifty more subscribers, in addition to those already secured in England, to justify the expense of an American edition. The needed names were soon secured; and an arrangement was also made with the Messrs. Appleton to reprint Mr. Spencer's earlier works. From the beginning of his acquaintance with these writings, my brother was convinced that they were destined to exercise great influence in this country, and this opinion has been fully confirmed.

Of my brother's experience as a lecturer, there is little room here to speak. He early showed an aptitude for making scientific subjects

intelligible and attractive to the unscientific, and was an impressive public speaker. His first course of lectures was on "The Chemical Relations of the Living World to the Atmosphere," and dealt with the geological history of the earth and with those large generalizations concerning the respiration of plants and animals that were shown to depend ultimately upon the forces of the sunbeam. These lectures were early examples of his fondness for broad scientific conceptions that bring together all departments of Nature, and his later lectures upon the "Chemistry of the Sunbeam," the "Dynamics of Life," etc., by which he was at one time widely known as a popular teacher of science, are also illustrations of this mental tendency.

The "Hand-Book of Household Science," published in 1857, was designed as a text-book for girls, and is another illustration of my brother's passion for applied science. He believed that the bearings of science upon the economy of the household was "first in the order of importance among things to be considered by rational and civilized people"; and that "it is the duty of popular education to communicate that information which can be reduced to daily practice and yield the largest amount of positive good." The book was a most painstaking labor, and is a mine of useful knowledge concerning matters of constant interest to everybody.

Professor Youmans was married in 1861 to Mrs. William L. Lee, the widow of a distinguished lawyer and jurist, and a lady of culture, refinement, and much critical literary ability. That a wife of such nice perceptions and intellectual gifts should earnestly sympathize with the literary and scientific work of her husband was to be expected. As his amanuensis, and as an assistant and companion in the occupations, correspondence, and travel, by means of which he was brought into intimate relations with the leading thinkers of England and America, she rendered him valuable aid which he highly appreciated.

"The Correlation and Conservation of Forces" (1864) is a collection of essays and addresses by the most eminent leaders of science concerning the new theory of the relations of forces, with an introduction by the compiler, prepared in order to bring forward certain facts in the history of discovery concerning the correlation and conservation of forces in which we as Americans have a special interest; and also to indicate several applications of the principles not treated in the body of the volume. At one time my brother was strongly urged to take the presidency of Antioch College. He did not entertain this proposal, but when asked to take the chair of Chemistry in that institution as non-resident professor, he accepted the appointment provisionally, and gave a course of lectures there in 1866. Various circumstances, however, made it impossible to continue the arrangement.

"The Culture demanded by Modern Life" (1867) presented a se-

ries of addresses and arguments on the claims of scientific education by more than twenty English and American thinkers. The editor was represented in the list by a lecture on "The Scientific Study of Human Nature" and an introductory essay on "Mental Discipline in Education," in which he attempted to show that a course of study mainly scientific not only meets the full requirements of mental training, but also affords the kind of culture or mental discipline especially needed in this country.

Besides his labors as a lecturer and in the preparation of his own works, and his efforts in behalf of Mr. Spencer's publications, Professor Youmans had all along been deeply interested in the reproduction here of the works published abroad by the leaders of modern scientific thought. Among the earliest which he urged the Appletons to republish were those of Whewell, Buckle, Darwin's "Origin of Species," and the writings of Spencer and Tyndall. He went to England several times on this errand, and, as a result of his exertions, the works of Huxley, Lubbock, Darwin, Lyell, Bain, Tyndall, Maudsley, Sully, Hinton, Bastian, Roscoe, Simpson, Proctor, Helmholtz, Bagehot, Mill, Carpenter, Mattieu Williams, and many others, were reprinted by the Appletons, and have been very popular with thoughtful readers in this country. The arrangement with the publishers was that the authors should be paid a publisher's copyright at the customary American rate.

Chiefly interested in the works of scientific and philosophical authors, who suffer most from lack of international copyright because their productions are in comparatively small demand, Professor Youmans planned the "International Scientific Series," and spent a year in Europe making arrangements for it with authors and publishers. After not a little hard labor, the series was finally organized on the basis of simultaneous publication in London, New York, Paris, Leipsic, Milan, and St. Petersburg, and of payment to the authors on the sales in all countries. The first volume, issued in 1872, was Tyndall's "Forms of Water," and was followed by Bagehot's suggestive work on "Physics and Politics." Other books that attracted attention to the merits of the series were Cooke's "New Chemistry," Spencer's "Study of Sociology," Draper's "History of the Conflict between Religion and Science," and Schmidt's "Doctrine of Descent and Darwinism." The series has reached, in Mr. Angelo Heilprin's "Geographical and Geological Distribution of Animals," its fifty-seventh number, and as a whole constitutes the most successful popular presentation of scientific and philosophical ideas ever attempted. None of the books have enjoyed a wider circulation than the "Study of Sociology" and the "Conflict between Religion and Science," both of which are remarkable for the boldness of their statements of new ideas. It thus appears that the foreign authors whose works were in charge of Professor Youmans have been for years in practical enjoy-

ment of international copyright at the hands of Messrs. Appleton by a systematic voluntary arrangement.

"The Popular Science Monthly" was started by the Appletons, at the suggestion of Professor Youmans, in 1872. The leaders of scientific thought in Europe were actively publishing their views in periodicals and in the transactions of learned societies, but the American public were without any means of keeping up with the drift of the new movement. Professor Youmans had persuaded Herbert Spencer to write the volume of "The Study of Sociology" for "The International Scientific Series," and it had been arranged that the chapters should first appear serially in "The Contemporary Review" in London and in some American magazine. Professor Youmans made arrangements for its publication in "The Galaxy," to which advance-sheets were to be sent. But the first installment came too late, it was said, for publication at the time agreed upon, and it was at this juncture that the necessity of establishing a new scientific journal in this country became apparent. In less than two weeks from the first conception of the project, and two days before "The Galaxy" appeared which was to have contained the delayed article, the first number of "The Popular Science Monthly" appeared. Considering that it was a scientific periodical, its success has been unprecedented.

But in the height of its usefulness the busy life is ended. Professor Youmans's constitution, originally robust, had been impaired by his sedentary habits. Want of sight left no inducement to out-of-door pursuits, while his chosen work always kept him in-doors; and it was not strange that, when exposure came, as it did in the winter of 1880–'81, his system should yield to the strain. He suffered a severe attack of double pneumonia early in the season, and this was followed by a succession of relapses, which left his lungs in a state so diseased that they never recovered. He was told by his physician that his chance for long life lay in the country and in open-air occupations; but conformity to these requirements seemed to him impracticable, and he went on with his usual work, though failing gradually in strength. In the late winter of 1885 he went South, but derived little benefit, and the following season declined to repeat the journey. About a year ago he was overtaken with loss of appetite, and consequent loss of flesh and strength, and then realized that his days were nearly numbered. During the last six months he was very feeble and emaciated, but his long sickness was borne without complaint, and his unselfishness and care for others were conspicuous to the last.

EDITOR'S TABLE.

DEATH OF PROFESSOR YOUMANS.

EDWARD L. YOUMANS, the projector of this magazine, and its editor from the opening number, died at his home in this city on the morning of Tuesday, January 18th, in the sixty-sixth year of his age. For nearly forty years he has been before the public as a teacher of science, either through his published works, on the lecture-platform, or in an editorial capacity; and though it may almost be said that he was cut off in the prime of his intellectual powers, it has been the fortune of few men of his generation to accomplish a larger amount of useful work. Leaving it to others who, less drawn by ties of kindred, and less dominated by the influence of long association, will be more competent to measure the impress he has made upon American ideas, it will be proper here to refer to the purposes and hopes which animated Professor Youmans in the establishment and conduct of "The Popular Science Monthly."

For years before the plan of the publication took definite form, he was frequently heard to deplore the inhospitable attitude of the periodical press, particularly in this country, toward the growing influence of science in the world of modern thought, and it was in order to open a way by which this influence might the more readily find access to the educated classes that the publication of the "Monthly" was first resolved upon. One of the earliest obstacles encountered, even before the magazine was fairly under way, was the active hostility of more than one of the leading periodicals of that time. The conductors of several of these journals, literary as well as religious, were intolerant of the views to which it was, among other things, the purpose of the "Monthly" to offer a channel of expression. Indeed, not only did they refrain from printing the writings of the leading scientific thinkers, but they seemed ever ready to condemn any means that might be employed to bring those writings before the public where they could be judged upon their merits. This was so much the case fifteen years ago, when the "Monthly" was started, that not one of the prominent magazines in the country would publish Mr. Spencer's papers on the "Study of Sociology"; yet so great was the change in public sentiment on these subjects, wrought by the "Monthly" under the guidance of Professor Youmans, that two of these very journals were among the earliest and most liberal applicants for Mr. Spencer's philosophical favors when he visited America ten years later.

Professor Youmans's conduct of this magazine has been marked by a sincere devotion to the search for truth and the diffusion of the most enlarged knowledge; by a careful exclusion of the merely sensational; by a vigilant solicitude to avoid misleading its readers through putting forth as science the unaccredited theories which so persistently seek public expression—with a quick readiness to correct errors into which he may have been inadvertently betrayed; and by a watchful care to keep abreast of the progress of science, particularly in its bearing on philosophy, education, ethics, social economy, etc.; and, above all, by constant adherence to the principle that "the highest value of science is derived from its power of advancing the public good."

Loyalty to the spirit and principles thus outlined was indicated in the opening announcement of the "Editor's Table" of the first number of the "Monthly," where it was declared that

the journal had been started "to help on the work of sound public education by supplying instructive articles on the leading subjects of scientific inquiry." It was there shown, further, that the meaning of the term science was widening, that it had come to be regarded as applying to the whole of Nature; "as being, in fact, a method of the mind, a quality or character of knowledge upon all subjects of which we can think or know." This implied a more critical method of inquiry in fields not before so strictly dealt with. Whatever subjects involved accessible and observable phenomena came within its range; it was the common interest of rational beings; and included in the immense extension of its conception all subjects of human interest. There was growing up a valuable literature of popular science in the shape of instructive essays and lectures from men who were authorities upon the subjects which they treated, for the diffusion of which adequate means were not yet provided. The "Monthly" would afford this, and in doing it would appeal not to the illiterate, but to the generally educated classes, and would seek to enable them to carry on the work of self-instruction in science.

To him may be literally applied what he wrote of Agassiz, on the occasion of his death: "He [Agassiz] had great enthusiasm and impulsiveness, and the whole fervor and intensity of his nature was spent in the single-minded pursuit of science. Not content with what he could himself know, and do, and enjoy, he was powerfully impelled to make others the sharers of his knowledge, his activity, and his pleasures. He not only won them to him by his geniality and his cordial and unaffected manners, but he inspired them with his own purposes, and moved them to his own ends." He was not content to be merely a scatterer of his own stores of knowledge; "he had a profound interest in popular education, but the soul of that interest was for improvement in its methods. In the matter of public instruction he was a revolutionist and a propagandist. He warred with current ideas and consecrated practices. He condemned in the most emphatic way the wretched lesson-learning routine that prevails in the schools. He denounced our wordy and bookish education as baseless and unreal, and demanded such a change in our systems of instruction as shall bring the pupils face to face with Nature herself, and call out the mind by direct exercise upon phenomena—the facts, laws, relations, and realities of the world of experience." All this is true of Professor Youmans; but it never entered his mind to assail existing systems till he believed he had something better and more effective to put in their place.

His faith and his heart were in his work, and he executed his self-imposed duties with a vigor, an earnestness, and a thoroughness that are peculiar to those who believe in what they are doing, and whose highest satisfaction is obtained in the consciousness of benefits conferred. Leaving this work—so persistently and so successfully carried on—to other hands, he has left along with it an example of conscientious devotion to principle, of outspoken allegiance to truth, and of unsparing self-sacrifice, that will remain a precious heritage to his friends, and may fitly serve as an inspiration to all who are striving for the general good.

FUNCTIONS OF THE STATE.

IN his article on "Socialism," in the new "Scribner," General Francis A. Walker, of Boston, advances two opinions that seem to us open to the gravest question. In the first place he apparently approves of the exemption of church property from taxation in so far as the practice is grounded on a belief that the interests of public order will

thereby be subserved. In the second place he bestows "the heartiest approval" on the "socialistic movement," as he himself describes it, for transferring "power and discretion in the matter of the education of children" from the family to the Government. Let us very briefly discuss both points.

The exemption of church property from taxation is equivalent, General Walker tells us, to a "subsidy of many millions annually. . . It is claimed," we are further told, "that the services of this agent are worth to Government more than the taxes which the treasury might otherwise collect from the smaller number of churches and missions which would survive the assessment of the ordinary taxes, and that the remaining tax-payers really pay less, by reason of the reduction in violence and crime hereby effected." Now the question that presents itself to our mind is this: What view might we expect a dispassionate and capable observer, like the President of the Massachusetts Institute of Technology, to take of an utterly unverified and utterly illogical claim of this nature? That it is unverified no one can deny. What *facts* are there to prove that, if church property paid taxes like other property, crime and violence would increase, and the general rate of taxation be advanced? Absolutely none. That the claim is an illogical one is equally evident. Why should state aid to the churches, if it really assists the cause of order, stop short at the exemption of church property from taxation? If a few millions in this way are of so much benefit, why not try the effect of a few millions more in the payment or supplementing of the salaries of ministers? Why not have a fund for the erection of church-edifices in spiritually destitute districts? Why not subsidize the Bible Society? Why not distribute tracts through the Post-Office letter-boxes? There is really no end to what the Government might do to aid the churches; and it is really very odd that any one should *seriously* pretend that the *whole* duty of the Government in the matter is done when it has "dead-headed" the churches on the assessment-roll. Or look at the same question from another side. If it is conceded, as it probably is by the great majority in this country, that state patronage of the Church is hurtful to the life and activity of the latter, why should it be held that the particular form of state patronage involved in exempting ecclesiastical property from taxation is beneficial? Why should it *not* be held that just as the Church has gained in spiritual vitality by being cut off from other forms of state support, so it would further gain by shaking itself free from this last remnant of the old system? If this view is correct—and we should like to know what solid arguments can be advanced against it—then, instead of a gain to social order by the remission of the taxes on ecclesiastical property, there must be an injury to that very cause through the moral injury inflicted on the churches. The whole argument referred to by General Walker is so hollow, so unscientific, so manifest a begging of the question, that we can not but be surprised at his omission to denounce it as such; and still more at his putting it forward as an argument valid enough, if only used genuinely, in the interest of good government. No one knows better than General Walker that the sincerity with which an argument is used has nothing whatever to do with its logical validity, but depends wholly on personal conditions. A very ignorant or stupid man may use with perfect sincerity an argument which a better-informed and clearer-headed man could not use without conscious sophistry. We should very much like to read an article from General Walker's pen dealing with the one question: *Should ecclesiastical property in the United States be exempted from taxation?* We feel persuaded that, when he

came to give us his own undiluted views upon that point, he would deal somewhat trenchantly with the argument above referred to, and not altogether in the direction of the brief notice contained in his article on "Socialism."

Next, as to the transfer to the state of the "power and discretion in the matter of the education of children." This, we are told, "deserves the heartiest approval . . . as a scheme for accomplishing good through state action, in a field properly pertaining to individual initiative and enterprise." It is a little difficult to understand how a field that "*properly* pertains to individual initiative and enterprise" can *properly* be encroached upon by the state. Some explanations on this point would be very acceptable. How can it be said that the field of education properly pertains to individual initiative and enterprise if the contention, indorsed by General Walker, is correct, that "the individual members of the state would be richer, and happier, and better, if power and discretion in the matter of the education of children were taken away from the family and lodged with the Government"? It seems to us that it is altogether too soon to bestow our "heartiest approval" upon this particular "socialistic movement." General Walker himself notes that "the immediate effects of popular instruction in reducing crime are in dispute." He might also note that this doubt has arisen almost wholly since the state has taken so prominent a part in the business of education. When education was in the hands mainly of the family, an education was universally thought to be the very best gift a father could bestow upon his son. Now, that the state is forcing education upon all, the value of the article has sensibly decreased; and many are beginning to doubt, looking both at moral and at intellectual results, whether in this matter society is not working in a wrong direction. A vast amount of thought has been bestowed during the last half-century upon educational methods; and yet we seriously doubt if there was ever more dissatisfaction with the general results of popular education than there is to-day. We could refer General Walker to an article that appeared a year or two ago in one of the leading newspapers of his own city, the "Boston Herald," setting forth the difficulty a certain insurance company had in finding, among a score of graduates of the Boston grammar-schools, a single youth competent to take a junior clerkship, the only qualifications for which were fair skill in figures, good handwriting, and a certain knowledge of the rules of English composition. Is it not the fact that "commercial colleges" have sprung up all over the country to supplement the deficiencies, from a business point of view, of the public schools? And in spite of the vast disadvantage at which state competition places all private tuition, the number of private schools and academies advertised in the papers is still very great. The effect upon the home of the wide assumption of educational functions by the state has yet to be fully ascertained; but already there are grave reasons for thinking it has been far from favorable. It is no small matter to take from the family the "power and discretion in the matter of the education of children"; and before we talk of giving our "heartiest approval" to the change, we should be quite sure that it is not going to loosen the very foundations of society. Our own opinion is that education is no part of the functions of the state, and that it would be better, therefore, to leave it in the hands of the family, even though the result were to show, in the course of a few years, a larger proportion than now of that kind of illiteracy which consists in not being able to read or write. We have known illiterates of that kind who could "give points" to people who could both read and write in the matter of common sense and general information. The question is too wide a one

for discussion in these columns; but we desire here to record our conviction that when "power and discretion in the matter of the education of children are taken away from the family and lodged with the Government," the rights and duties of the family are seriously invaded, and that no good can come of it in the long run.

MR. GRANT ALLEN visited America last year for his health, and not on an errand of scientific observation. Yet, that his well-known habit of looking closely at what he saw, and questioning it for the instruction it might yield, was not relaxed, is shown by the very interesting and suggestive article which he has contributed to our pages this month on "A Mount Washington Sandwort." The history of the plant, as he elucidates it, is most interesting, and can not fail to give us broader views of the effect of glacial action upon the distribution of life over the earth.

LITERARY NOTICES.

THE FIRST THREE YEARS OF CHILDHOOD. By BERNARD PEREZ. Edited and translated by Alice M. Christie. With an Introduction by James Sully, M. A., author of "Outlines of Psychology," etc. Chicago: A. N. Marquis & Co., 1885. Price, $1.25.

THE aim of the author in the preparation of this work is to follow out, in little children, the gradual awakening of the mental faculties during the first three years of life. He is a painstaking, exact observer, and seems in some way to have had exceptional opportunities for the prolonged acquaintance of a good many different babies from the first days of their mundane experience. He has, besides, made excellent use of the labors of others in the same field, when their facts were well observed and well described, and their ideas grew out of real experience. His abundant material is carefully sorted and arranged for illustrating and enforcing his view of infant psychology. His facts are simply described, and are most frequently given in the form of anecdotes, and his interpretations of them are both sympathetic and scientific. He has a rare faculty of interpreting the external signs of infantile feeling. M. Perez is deeply interested in all practical questions concerning education, and is the author of a work entitled "Education from the Cradle." He is a good physiologist and psychologist, and notwithstanding his native fondness for children, he subjects them to rigorous scientific scrutiny. M. Perez is an intelligent evolutionist, and is also deeply interested in comparative psychology, and in his interpretations of the facts of child-life he makes excellent use of all the latest developments of science. An idea of the scope of the work will be best gained by a glance at the table of contents. Chapter I treats of the faculties and first impressions of the new-born child. Chapter II describes the motor activities—at the beginning of life, at six months, and at fifteen months. Chapter III considers the emotional sensations and the first perceptions. Chapter IV deals with the instincts, general and special, and Chapter V with the sentiments. Chapter VI discusses intellectual tendencies under the heads of Veracity, Imitation, and Credulity. Chapter VII is devoted to the will; and Chapter VIII to attention and memory. In Chapter IX association and imagination are considered; and Chapter X, on the elaboration of ideas, treats of judgment, abstraction, comparison, generalization, reasoning, and errors and illusions. The remaining three chapters are given severally to expression and language, the æsthetic sense, and the moral sense.

The introduction by James Sully, author of "Outlines of Psychology," is a valuable addition to the work. We quote his closing remarks: "A last feature of this volume which is deserving of mention is its thoroughly French form and style. The reader feels at every page that he is listening to a Frenchman who knows how to shape his materials, give order and arrangement to his exposition, light it up with pertinent illustration, and adorn it with the graces of style. While in places the author ventures a few steps into the darker recesses of metaphysical psychology, he never forgets that he is writing a popular work. And he has succeeded in producing a volume which, while

it will be of special interest to the scientific student, will attract the general reader as well.

"It may not be superfluous to say, perhaps, what I feel sure the author himself would indorse, that this volume makes no pretension to be a final and exhaustive study of its subject. A complete theory of the infant mind will need to be built up by the combined efforts of many observers and thinkers. In the region of psychology, much more than in that of the physical sciences, repetition of observation and experiment is needed to check and verify the results of individual research. The secrets of infancy will only be read after many pairs of eyes have pored over the page. Though, as observed, M. Perez has made his studies unusually wide, it may be reasonably doubted whether, in some cases, he does not give exceptional instances as typical and representative. Certain it is that his notes respecting the first appearance of sensations—e. g., those of taste and smell, of the perceptions of distance, etc., of the movements of grasping objects, etc.—differ in some important respects from those of other observers. In certain particulars, too, this volume is less full than some other records, notably that of Professor Preyer's 'Die Seele des Kindes,' which, as it was published after the work before us, is not referred to. Hence, the student who wants to be quite abreast of the present results of research, will do well to read other records in company with this. This circumstance, however, does not in the least detract from the value of 'The First Three Years' as a rich mine of facts, and one of the fullest if not, indeed, the very fullest, monograph on its subject."

ELEMENTS OF THE COMPARATIVE ANATOMY OF VERTEBRATES. Adapted from the German of ROBERT WIEDERSHEIM, by W. NEWTON PARKER, with Additions by the author and translator. With 270 Woodcuts. Pp. 345. Price, $3.

WE are indebted to an Englishman for another excellent work on the comparative anatomy of the vertebrates. It is true that this publication is a translation of Wiedersheim's excellent work, published at Jena in 1884. But a book rescued in this way from a nation which is too often content with books printed on poor paper, with crabbed type and interminable sentences, and placed before us by an original worker with his own annotations and additions in language and type which are as luminous as they are precise, is a boon for which one may be truly thankful.

The subject-matter is arranged according to organs and not according to groups of animals, and one must have a general knowledge of the animal kingdom, and especially of its classification, to fully profit by the work. This arrangement, as the author says, "seems to be the only possible one if the book is to be founded on a scientific basis, for it is most important that the student should grasp the fact that there has been an evolution of organs as well as of animals." The illustrations are numerous and most excellent. There is nothing more exasperating to a student than a dingy and well-worn anatomical woodcut, rendered a perfect muddle by a halo of diminutive and broken type connected with equally broken lines which penetrate the drawing like skewers, and become hopelessly entangled in a mesh of muscular fibers and tissues. It is refreshing to get hold of this work of Wiedersheim's with its clear and ample engravings, rendered intelligible by large guiding initials, with their dotted lines connecting definitely with structural details in the drawing, and there stopping.

Some slight errors, however, have crept in, as the statement that the tarsus of birds consists in the embryo of three elements instead of four. As the author so often deals with his subject ontogenetically, he should have referred to the rudimentary pelvis in the whales and certain limbless reptiles. As excellent descriptions with diagramatic figures are given showing the development of the feathers and hair, a paragraph might have been devoted to the development and various modifications of the claw, hoof, and nail, with the statement that in certain birds the embryo possesses the rudiments of nails on the digits of the wing.

The chapter on the urogenital organs, accompanied by excellent diagrammatic as well as shaded illustrations, especially those showing these parts in the monotremes and marsupials, will be appreciated by students.

Each section of the subject closes with

a brief bibliography, and the book ends with a good index.

PRECIOUS STONES IN NATURE, ART, AND LITERATURE. By S. M. BURNHAM. Boston: Bradlee Whidden. Pp. 400, with Plate. Price, $3.50.

WHEN beauty in any mineral that may be found in Nature is accompanied by a corresponding rarity of the same, so that possession for ornamental purposes is only possible to those having wealth or power, the material belongs to the class of precious stones. Although precious stones are not indispensable to the world's progress, they flatter human vanity, and have therefore a not unimportant place in human affairs. The large money value a precious stone represents compared with its volume, rendered this sort of property valuable in former times as an additional medium in commercial interchange; the perfected banking methods of the present day have, however, relegated precious stones to their proper field—adornment and as curiosities.

The author does not discuss the usefulness of precious stones. Since they are used, have been always used, and are a very important article of commerce and industry, he tells us all he knows about them or has been able to gather from other authors; origin, properties, classification, prices, trade, pawns, sumptuary laws, size, collections, crown-jewels, secular and sacred uses, their place in literature, mystical properties, and engraving on precious stones. Many historical facts are given which make the book very readable and interesting. The above subjects are distributed in the first nine chapters. The following chapters are devoted to the description and histories of the different varieties of precious stones. Among these the diamond occupies the first place. In two chapters the history, home, mining, trade, polishing, etc., of the diamond are minutely given, accompanied by much historical information. Another is devoted to historical and remarkable diamonds. The history of each of these stones—or as much as is known—is given in each case. The record is not what would be considered the best part of human nature. Murder, wars, artifice, theft, plunder, and treachery are the jewels on which the larger number of these remarkable diamonds are set, and very few of these historical diamonds have a clean history. The largest diamond known is the Braganza, or King of Portugal, weighing from sixteen hundred and eighty to eighteen hundred and eighty carats uncut, the genuineness of which is, however, doubted. There are two, the Matan and Nizam, weighing over three hundred carats, uncut, and seven, four of which are cut diamonds, weighing between two and three hundred carats. The diamond loses about one third of its weight by cutting.

The diamond is pure crystallized carbon. The stones which belong to the class of the precious corundum, which is supposed to be nearly pure alumina, are the most valuable after the diamond. They are sapphire, asteria, emerald, amethyst, topaz, and ruby.

The beryl class includes several varieties: the emerald, acquamarines, and topaz, which, to distinguish them from those of the corundum species, are termed Occidental, while these are termed Oriental. The difference in composition is that the beryl species contain silica and other substances besides alumina. Opals and pearls: spinet, garnet, tourmaline, turquoise, lapis-lazuli, chrysolite, chrysoberyl, iolite, kyanite, apophyllite, labradorite, and other gems, and the crystals of the quartz family, are described in the last four chapters.

There are six appendices, giving the size of the largest diamonds; classification of precious stones according to their constituents; hardness, and specific gravity, and relative hardness, relative specific gravity, localities in the United States where gem-minerals have been found.

MIND, No. XLV. January, 1887. London: Williams & Norgate.

THE present number is unusually rich. The leading article is by Professor William James, of Harvard University, entitled "The Perception of Space." Professor Henry Sidgwick writes a criticism upon Dr. Martineau's ethics, and James Ward, author of the article upon psychology in the new edition of the "Encyclopædia Britannica," replies to some comments of Professor Bain upon his work. J. M. Cattell, Ph. D., contributes an account of some interesting experiments on the association of ideas. Five critical notices by Professor A. Seth,

Thomas Whittaker, James Sully, Grant Allen, and Professor R. Adamson, deal respectively with vol. ii of J. H. Green's philosophical works, C. Rendouvier, J. Delbœuf, M. Guyau, and J. Volkelt. All these criticisms are exceptionally able. The notes upon new books are copious and interesting.

HAND-BOOK OF ZOÖLOGY, WITH EXAMPLES FROM CANADIAN SPECIES, RECENT AND FOSSIL. By Sir WILLIAM DAWSON, LL. D., F. R. S., etc. Third edition, revised and enlarged. Montreal: Dawson Brothers, Publishers. Pp. 304. With 317 Figures and 9 Plates. Price, $1.25.

THIS little book, as its name implies, is a hand-book of zoölogy. Chapter I, under "Physiological Zoölogy," deals with the tissues and functions of the animal. Chapter II treats of "Zoölogical Classification," and following these is a rapid survey of the animal kingdom, fully illustrated by woodcuts, which, in the majority of cases, were used in the first edition of this work, published in 1869. Some of the cuts are exceedingly poor, though in the main correct. Fossil forms are presented with the recent forms as they should be, and so one gets a better idea of the range of the animal kingdom. It is a book that the amateur collector and the young zoölogist should have, as much information in a condensed form is embodied in its pages.

It might be expected that the book would be conservative and somewhat antiquated, from the known antagonism of its author to the modern views of derivation. It is interesting to see, however, that the leaven of evolution is working slowly but surely even here.

In the preface to the first edition, Sir William says: "I have avoided the modern doctrines of a 'physical basis of life,' and of 'derivation,' because I believe them to rest on grounds very different from true science, and therefore to be unsuitable for the purposes of a text-book." Having in the first edition arranged his material rigidly under the branches of Cuvier, he says: "I have not scrupled to adhere to them, as the expression of a grand and philosophical idea, essential to an accurate and enlarged conception of Nature"; and, again: "This fourfold division includes the whole animal kingdom, and is the only rational one which can be based on type or plan of structure. . . . The attempts which have been made to introduce additional branches or provinces I regard as retrograde steps; such, for example, is the province Cœlenterata of Leuckart," etc., etc. And now in sixteen years—a long time, it is true, for most minds to admit so much—we find the author not only cancelling his protests against a physical basis of life and derivation, but reluctantly taking the retrograde steps in adopting essentially the classification of Leuckart, Cœlenterates and all, though he turns back longingly to the quatenary classification of Cuvier, which he says may still be regarded as of scientific value.

May many active years of work be vouchsafed to this delightful and charming naturalist, and in these years may he prepare another edition of his hand-book, with still further omissions and admissions!

AN ELEMENTARY COURSE IN PRACTICAL ZOÖLOGY. By BUEL P. COLTON. Boston: D. C. Heath & Co. Pp. 185. Price, 85 cents.

MR. COLTON has produced an admirable book in the one before us. A student will certainly get a clear idea of the animal kingdom if he follows the stimulating advice and directions which the book offers. The following plan of study is carried out:

1. Directions are given for collecting and preserving the specimens.
2. The live animal is studied.
3. The external features are noted.
4. The animal is dissected.
5. The development of a few forms is traced.
6. After studying each animal, its relations to other animals are considered (classification).

He has avoided the almost universal practice, so common in English and most American text-books, of commencing with the lowest known forms of life, and following up step by step to the highest, thus unavoidably conveying the false idea of a continuous ladder in creation. On the contrary, he commences his examinations with the insects as being animals that every one may easily get. The pupil is told how to see and what to see, and is permitted to

express himself in his own words. Suggestive inquiries are made which make the student and teacher companions in the work of study and investigation. A good text-book requires a good instructor, and this book is no exception to the rule.

In the usual courses of study in the schools of this country, the teacher has some knowledge of the subject; that is to say, he can pass some sort of an examination in algebra, geometry, rhetoric, and similar studies, or, at least, it is assumed he can; but we venture the assertion that not one teacher in a hundred, into whose hands text-books of zoölogy are placed, could tell whether a spider had six legs or eight, or whether it breathed through its mouth or otherwise.

This book, most excellent in its plan and execution, will probably be in the hands of every intelligent teacher of zoölogy, while the ordinary school boards will probably impose the short six-foot cuts across-lots, in preference to longer and more instructive paths. This is not a supposititious case, for some years ago, a gentleman interested in the publications of D. Appleton & Co., on visiting a certain high-school in Indiana, was gratified to find the blackboards covered with drawings copied from Morse's "First Book of Zoölogy." On inquiry, he found that the teacher alone possessed a copy, from which he was really teaching, while the school board had introduced another book which the entire class possessed, and from which they were reciting, parrot-like, the lessons!

PEABODY MUSEUM OF AMERICAN ARCHÆOLOGY AND ETHNOLOGY, Eighteenth and Nineteenth Annual Reports. Cambridge, Mass. Pp. 124.

THE nineteenth report is dated April 9, 1886. The interest of the document centers in the report of the Curator of the Museum, in which are recorded investigations made under the direction or with the co-operation of the Museum in various parts of the United States and in Central America. The investigations to which the most attention has been directed were conducted in Ohio, chiefly in the mounds of the Little Miami Valley. A brief exploration was made among the mounds near Chillicothe, and furnished relics forming an important link connecting the people who built the earthworks in the Scioto Valley with the builders of the singular group on the Turner farm in the Little Miami Valley. In the latter region several small mounds and a part of a large cemetery were explored under the direction of Dr. Metz. From the cemetery, which is across the river from the ancient cemetery near Madisonville, many thousand specimens, and many skeletons were obtained. For the first time the large pipes cut in stone in the form of human figures have been found associated with the skeletons—a discovery which connects these articles, hitherto only casually found on the surface of the ground with the people who used them, and which, with other circumstances, throws light on the burial ceremonies of those people. Examinations were made of some mounds on the bluffs of the Mississippi, in Pike County, Illinois, and less thorough ones of mounds in Calhoun County, on the Illinois River, from the results of which the interesting conclusions were drawn that the two sets of mounds were not built by the same people; and that "the burial-mounds of the Illinois bluffs resemble in contents, size, and structure the simple burial-mounds of the Ohio Valley, while those on the Mississippi bluffs have nothing in common with them except that they are burial-mounds." A special paper is given to an account of the exploration of the "Marriott Mound," in the Little Miami Valley, and the description of its contents; and a paper by Dr. W. F. Whitney, "On the Anomalies, Injuries, and Diseases of the Bones of the Native Races of North America." Accounts are given of the discovery of human bones in mounds near Trempealeau, Wisconsin; of Dr. Abbott's continued investigations in the Trenton gravels; of the explorations of shell-heaps in Maine; and of Miss Fletcher's studies of living Indian customs among the Omahas, and her gift to the Museum of the objects which those Indians had carefully preserved for many generations in their Sacred Tent of War." From Dr. Flint, in Nicaragua, have been received four blocks of tufa bearing human foot-prints, which were found under several layers of volcanic material, on the shores of Lake Managua; and several orna-

ments of jadeite, precisely like the Chinese jadeite. The later of the two reports contains some interesting references to the history of the Museum and its foundation, the growth of the collections and their arrangement in the cases. The entries in the catalogue of the collections have reached the number 38,840; but this gives no index to the actual number of objects; for the entries refer to sets as well as to single objects, and one entry may often stand for many objects.

THE EARTH'S ANNULAR SYSTEM; OR, THE STORY OF THE ROCKS. By G. N. VAIL, Barnesville, Ohio. Published by the Author. Pp. 400. Price, $2.

PROFESSOR VAIL propounds a new theory of the formation of the earth and the origin of the geological systems. It is in effect an adaptation of the nebular hypothesis, and supposes that a large part of the matter that now forms the crust of the earth, together with the waters, was held in suspension through the ages, in the form of vaporous rings, and, as the vapors gradually cooled and condensed, the rings fell to the earth by virtue of the laws of gravity. These successive downfalls mark the various ages, periods, and epochs into which geologists divide the history of the earth's crust, Jupiter and Saturn are cited in support of the theory as planets which are still going through this process. The author believes that he is able by the application of his theory to explain such obscure matters as the numerous floods which geologists assert have fallen upon the earth; the absence of the rainbow previous to the Noachian deluge, and many other statements in Genesis; "dust-showers"; the rise and fall of vast areas of the earth's surface, changes by denudation, etc.; the apparent retardation of the moon; the "great ice age"; the origin of the limestone strata; and the origin of coal. He asserts that he is a practical geologist who has made his studies in the field, and has drawn his conclusions from them.

DISEASES OF THE DIGESTIVE ORGANS IN INFANCY AND CHILDHOOD. By LOUIS STARR, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 385. Price, $2.50.

THE author's object in this book is to give prominence to a class of disorders which, while they are very usual in childhood, are yet too briefly considered in medical works. He regards the clinical investigation of disease in children as in some respects easier than the same study in adults. It is not complicated by circumstances of past life, yet there are very grave difficulties to be encountered in it, arising out of the sufferer's inability to give an accurate, or any, description of his feelings; and another source of embarrassment lies in the rapid growth and development of infants and the suddenness of their attacks, and the violence of the symptoms. Hence, the clinical investigation involves the three items of questioning the attendant for that which the child can not tell, inspecting the child, and physical examination. The importance of giving attention to the general regimen is particularly insisted upon. "So much may be done by the selection of suitable food, by artificial digestion, by regulating the clothing, bathing, and other elements of hygiene," that this factor is regarded as quite as important as the administration of drugs.

A HISTORY OF THE FRENCH REVOLUTION. By H. MORSE STEPHENS. In three volumes. Vol. I. New York: Charles Scribner's Sons. Pp. 533. Price, $2.50.

MR. STEPHENS presents, as the valid reason for producing a new history of the French Revolution, the fact that a very large amount of new material has recently been brought to light, embodying many facts before unknown, and presenting other facts in a new aspect, which the great historians and the more popular ones following them did not possess, and therefore did not use. In other respects, he claims to be animated by a great enthusiasm for his subject, and believes it to be the most fascinating in its interest and the most valuable for its political lessons in the history of the world; that he has worked at it diligently for years, to the exclusion of everything else, and has striven to be impartial in his treatment of it. The new matter of which Mr. Stephens has been able to avail himself is, as he describes it in the preface, copious and varied. It comprises local histories, which have been published in considerable profusion, with histories of special periods and even days, and articles in magazines and reviews and the bulletins of local

archæological and historical societies and academies; biographies of the great personages of the Revolution; memoirs on the relations between France and Europe during the revolutionary period, or what may be called the foreign policy of the Revolution; and the publication of documents. The author traces a bond of connection of the Revolution with America, for, "without the successful termination of the American War of Independence, it may be doubted whether the French Revolution would have developed as it did, or whether it would have taken place at all." We have still another community of interest in the subject, for "nearly every expedient, whether socialistic or purely democratic, which has been proposed of recent years for benefiting the condition of the people, was tried between 1789 and 1799, and if history has any value at all, it is this period which ought to be examined before any other, in order to learn the political lessons which it teaches."

THE PEDIGREE OF DISEASE. By JONATHAN HUTCHINSON, F. R. S. New York: William Wood & Co. Pp. 113. Price, $1.25.

THIS volume includes six lectures on temperament, idiosyncrasy, and diathesis, which were delivered in the theatre of the Royal College of Surgeons. The author starts out by deducing from the examination of the facts supposed to indicate temperament, the conclusion that part of those facts are merely the characteristics of different races, and another part merely the products of past disease—personal or inherited; so that, giving these what belongs to them, there is little left of it. Idiosyncrasy is defined as a peculiarity of constitution in some one particular feature developed to an excessive height or "individuality run mad." As here treated, it concerns special liability to certain diseases or to peculiar affections from particular kinds of food or drugs. Diathesis is the same in a less definite and rather vague form. In the discussion of it the author considers three great universal diatheses dependent upon the very commonest causes of disease by which man and other beings have been assailed from primeval times—the catarrhal, the rheumatic, and the scrofulous. Close to these are others of less importance but of parallel nature, and comprising all within range of liability—those of senile degradation and malignant new growths (cancer). Following these are other important diatheses, widely spread but not universal, since they depend upon local exposure; while hesitation is expressed whether the malarial diathesis ought not to be regarded as primary or universal. These views involve the recognition of the doctrine of hereditary transmission, and indicate that we ought to study disease as being, not of recent origin, or in dependence solely upon existing influences, but rather as that in which many seek truthfully to "read the record of a long descent."

OUTLINES OF LECTURES ON PHYSIOLOGY. By T. WESLEY MILLS. Montreal: W. Drysdale & Co. Pp. 200. Price, $1.

THE author of this book is Professor of Physiology in McGill University, Montreal. The "Outlines" consist of the simplest and briefest statements of the principles of the science, such as might have served for the notes out of which the fuller lectures were elaborated. They appear to cover the whole field in its several departments, and to be adapted to give to the student who masters them such command of the subjects as books can afford, and to guide him in his experiments. An introductory chapter on general biology, and an appendix containing laboratory exercises in practical physiology, are also given.

ELEMENTARY POLITICS. By THOMAS RALEIGH. London: Henry Frowde. Pp. 163. Price, 25 cents.

ACCEPTING the observation which some one has made, that "if men would only define the terms which they use in argument, most controversies would end before they begin," Mr. Raleigh has attempted in this useful little book to define the terms which are commonly used in political argument. The book is not meant to be a compendium of information, nor a summary of orthodox political doctrine; "not to satisfy but to stimulate inquiry"; not to form the reader's opinions, but to induce him to form opinions of his own. The chapter headings under which the definitions are given are,

"The Origin of Society," "Primitive Society," "Civilization," "Modern Society," "The Modern State," "The Constitution of a State," "Elections," "Political Ideals," "Parties and Party Government," "Wealth, its Production and Exchange"; "Competition, Monopoly, Rent"; "The Distribution of Wealth," "Social Inequalities," "The Functions of the State," and "The State and Social Reform."

How to Strengthen the Memory. By M. L. Holbrook, M. D. New York: M. L. Holbrook & Co. Pp. 152. Price, $1.

This book has grown out of the author's own experiences and observations. It aims rather to determine the principles upon which the memory may be cultivated and improved than to develop a new system of mnemonics, the use of which, it is justly observed, "is like employing a large amount of machinery to accomplish a small amount of work." The principles which are set forth as fundamental to the cultivation sought, are the laws of association, comparison, attention, repetition, and the securing of a vivid first impression. These being observed, minor details will easily be learned. "Those who wish to possess memories of great power," the author remarks, "and become able to master the most difficult subjects, if Nature has not given them the requisite ability, can do so by hard work, and by no other means. All will find that the rational methods of memory culture advised will not only strengthen this faculty, but every other intellectual faculty."

The Hygiene of the Vocal Organs. By Morell Mackenzie, M. D. London and New York: Macmillan & Co. Pp. 223. Price, $1.50.

This volume is designed to be a practical hand-book for singers and speakers. The author has been engaged in the treatment of diseased throats for a quarter of a century, and asserts that every singer or actor of note in England, with hardly an exception, at one time or another, came under his hands. He believes, therefore, that he has had unusual opportunities for studying the conditions which affect the voice. An understanding of the relation of the vocal organs to the general economy is insisted upon as an essential prerequisite to all proper training of the voice. "Singers and speakers," it is remarked, "are not only artists but also in a certain degree athletes, their work consisting essentially in well-ordered muscular movements. A man may be trained for a foot-race or a boxing-match by methods which, while calculated to develop the special qualities required for the performance of the feat, may be simply disastrous to the health of the body as a whole. In like manner an unintelligent teacher may seek to develop the voice at the expense of its owner's constitution." Some knowledge of the elementary laws of health is therefore an indispensable part in the equipment of the vocal instructor.

Ten Dollars Enough. By Catherine Owen. Boston and New York: Houghton, Mifflin & Co. Pp. 279. Price, $1.

It was a novel idea to throw a treatise on housekeeping, with receipts for preparing the dishes to be served at dinner, etc., into the form of a story, but the author has done it, as she desires to have the housekeeping she teaches executed, well. That is, she has told an entertaining story, and has packed it with practical receipts for cheap, appetizing dishes. The purpose of the book, as declared in the sub-title, is to show how keeping house has been done well on ten dollars a week, and how it may be done again. The prices of provisions quoted are ordinary New York prices, and for the articles in their season. The heroine "was keeping house with some luxury, on the same amount of table-money as many require to live very plainly. This could not be done except by buying everything only in its season; if beyond a certain price, she waited for it to get lower." A housekeeper who has read the book with care, declares that the author deserves a vote of thanks for the service she has rendered in it to good and cheap living.

A Hand-Book of Hygiene and Sanitary Science. By George Wilson. Philadelphia: Blakiston, Son & Co. Pp. 520. Price, $2.75.

This is the sixth edition of Dr. Wilson's valuable manual. The scope of the book is public hygiene, and having this in view, and to prevent the volume from growing to too large a size with the additions that

have been made to it, along with matter that has become obsolete, some subjects appertaining to domestic hygiene have been omitted, or rather transferred to a supplementary work. After the definitions and the historical introduction, the subject is considered under the general headings of "Food"; "Air, its Impurities, and their Effects on Public Health"; "Ventilation and Warming"; "Water"; "Water Analysis"; "Impure Water, and its Effects on Public Health"; "Dwellings"; "Hospitals"; "Removal of Sewage"; "Purification and Utilization of Sewage"; "Soils and Localities—their Influence on Public Health"; "Infectious Diseases—their Mode of Propagation and Prevention"; "Disinfectants and Disinfection"; "Vital Statistics"; and the "Duties of Medical Officers of Health." In addition to what was contained in former editions, there have been given in the section on the examination of food, brief descriptions of diseases which render the flesh of animals unfit to be eaten; new matter on water analysis and the analysis of sewage and effluents; the chapter on soils and localities and their influence on health is new; the chapter on infectious diseases has been remodeled; and subjects relating to disinfection are treated more fully.

THE STUDENT'S HAND-BOOK OF HISTORICAL GEOLOGY. By A. J. JUKES-BROWNE. London: George Bell and Sons; New York: Scribner & Welford. Pp. 597.

DR. JUKES-BROWNE, having already published a volume on physical and structural geology, the present treatise, on paleontological and historical geology, is given to complete the student's curriculum. It preeminently concerns British geology, and is intended to present the history of the rocks of the British Islands, while Continental geology is drawn upon, in a supplementary way, only so much as is necessary to fill up the gaps in the British records and complete the outline of the history. Prominence has been given to such stratigraphical facts as throw light on the physical and geographical conditions under which each group or system of rocks has been accumulated; but in this department, where so much room is left for the imagination to work and there is so much temptation to give it freedom, the author has endeavored to confine himself to such inferences as might reasonably be deduced from a study of the facts. Illustrations are given representing typical fossils and sections of country, and they are clearly engraved.

THE BUCHHOLZ FAMILY. By JULIUS STINDE. Translated by DORA SCHMITZ. New York: Charles Scribner's Sons. Pp. 262.

THIS series of "Sketches of Berlin Life" is one of the most popular and one of the most amusing books ever published in Germany; a fact which is partly indicated by the mention in the title-page that the translation is made from the forty-ninth edition of the German original, while the story is only two years old. The heroine, Frau Buchholz, tells her own story of the troubles she got into by her intermeddling and jealousy, revealing in every incident how that she is the blunderer and to blame for all that is disagreeable, yet always totally unconscious that her conduct has not been marked by strict propriety and perfect tact. As a picture of German middle-class vanity and the weaknesses that attend it, the story has rarely been excelled; yet it is all told in perfect good-humor, with the most evident fidelity to nature, without exaggeration or malice. The translation is usually done with grace and spirit.

A MANUAL OF LITHOLOGY. By EDWARD H. WILLIAMS, JR. New York: John Wiley and Sons. Pp. 135. Price, $1.25.

THE author is Professor of Mining Engineering and Geology in Lehigh University. In the classes, after thorough grounding in crystallography and mineralogy, the student begins the study of rock-formation. The theory and definitions are first acquired, and afterward a practical knowledge of the rocks is obtained by the examination of specimens. The object being to enable the student to classify at sight the more common species, only the macroscopic peculiarities are given. Mr. Williams has sought in this manual to combine a thorough knowledge of the elementary portion of the subject, with a brief account of the principal rocks, and a ready method for their determination.

MINERAL SPRINGS OF THE UNITED STATES. By A. C. PEALE, M. D. Washington: Government Printing-Office. Pp. 235. Price, 20 cents.

THIS paper is published as "Bulletin" No. 32 of the United States Geological Survey. The author's first effort was to obtain a list of the springs. All previously existing lists were found to be incomplete. The fullest one—that of a committee of the American Medical Association, referred to as "Pepper's List"—gave about 500 localities of springs. Others described, respectively, 171, 181, and 173 localities. The present lists include 2,822 localities, more than 600 of which are places of resort, and more than 200 sell the waters. Yet they are not regarded as complete, but only as preliminary to more detailed work which it is hoped may follow in the future. The information has been derived primarily from State geological reports and maps, various scientific publications, and members of the Geological Survey who have had opportunities of visiting different parts of the country. The results of analyses are given, where analyses have been made.

PUBLICATIONS RECEIVED.

Deist, R. Scraps of Philosophy for Skeptics. Knoxville, Tenn.: Zuberbuehler. Pp. 48. 25 cents.

Scudder, M. L. The Labor Value Fallacy. Chicago: The Patriots' League. Pp. 112. 10 cents.

Chicago Manual Training-School. Fourth Annual Catalogue, pp. 16.

McPherson, S. J. Hand-Culture and Character. Chicago Manual Training-School. Pp. 23.

Gladstone on the New Locksley Hall. New York: Brentano Bros. Pp. 39. 25 cents.

Walcott, Charles D. Second Contribution to the Studies on the Cambrian Faunas of North America. Washington: Government Printing-Office. Pp. 369.

Scudder, S. H. Systematic Review of our Recent Knowledge of Fossil Insects. Washington: Government Printing-Office. Pp. 128.

Peale, A. C. Lists and Analyses of the Mineral Springs of the United States. Washington: Government Printing-Office. Pp. 235.

Diller, J. S. Notes on the Geology of Northern California. Washington: Government Printing-Office. Pp. 28.

Jeffries, B. J. Some Medico-Legal Cases under State and National Laws. Boston. Pp. 11.

Wisser, John P. Compressed Gun-Cotton for Military Use. New York: D. Van Nostrand. Pp. 164.

Allison, Edward P. The City Government of Philadelphia. Baltimore: N. Murray. Pp. 72.

Report of the Board of Commissioners of the Geological Survey of Pennsylvania. Philadelphia: William A. Ingham. Pp. 6.

Rotch, A. Laurence. Account of the Foundation of the Blue Hill Meteorological Observatory. Boston: Alfred Mudge & Son. Pp. 29.

Bliss, James A. Boston. The History of the Discovery of Transtacial Mediumship. Pp. 46.

Anti-Convict-Contract Association Report. Chicago: L. T. Mansfield. Pp. 78.

The Swiss Cross. Vol. I, No. 1. Monthly. New York: N. D. C. Hodges; London: G. E. Stechert. Pp. 40. 15 cents.

Safford, Truman Henry. Mathematical Teaching and its Modern Methods. Boston: D. C. Heath & Co. Pp. 47. 25 cents.

Peale, Seaman and White. Report on Stating Water Analyses. Washington: Chemical Society. Pp. 11.

The Rhythm and Innervation of the Heart of the Sea-Turtle. T. Wesley Mills, Professor of Physiology, McGill University, Montreal. Pp. 24.

Cocoa and Chocolate. Dorchester, Mass.: Walter Baker & Co. Pp. 165.

Fiske, D. T. The Creed of the Andover Theological Seminary. Boston: Cupples, Upham & Co. Pp. 35.

Ingalls, J. K. Economic Equities. New York: The "Truth-Seeker" Company. Pp. 68. 25 cents.

Ingersoll, Robert G. A Lay Sermon. New York: The "Truth-Seeker" Company. Pp. 25. 5 cents.

Report of Spencer F. Baird, Secretary of the Smithsonian Institution. Washington: Government Printing-Office. Pp. 83.

Report of the Superintendent of the United States Naval Observatory. Washington: Government Printing-Office. Pp. 20.

Hague, A., and Iddings, J. P. Volcanic Rocks of the Republic of Salvador, Central America. Reprinted from the "American Journal of Science." Pp. 7.

Iddings, J. P. The Nature and Origin of Lithophysæ, and the Lamination of Acid Lavas. Reprinted from the "American Journal of Science." Pp. 9.

Bilgram, Hugo. The Iron Law of Wages. Reprinted from "The Age of Steel." Pp. 8.

Becker, George F. The Texture of Massive Rocks. Reprinted from the "American Journal of Science." Pp. 9.

Brinton, Daniel G. The Phonetic Elements in the Graphic System of the Mayas and Mexicans. Reprinted from the "American Antiquarian." Pp. 13.

Imports and Exports of the United States. Report by Chief of the Bureau of Statistics. Washington: Government Printing-Office. Pp. 259.

Winchell, N. H. Geological and Natural History Survey of Minnesota for 1884–1885. St. Paul: J. W. Cunningham & Co. Pp. 353.

Dimmock, George. Belostomidæ and some other Fish-destroying Bugs. From the Annual Report of the Fish and Game Commissioners of Massachusetts. Pp. 8.

Le Revell Littéraire (The Literary Awakening). Semi monthly. Prospectus No. Quebec: John Brennan. Pp. 16. $2 per annum.

Eleventh Annual Report of the President of Johns Hopkins University. Baltimore: George W. Dobbin. Pp. 100.

The Relations between Sanitary Science and the Medical Profession. Lowell, Mass.: N. Allen. Pp. 14.

Youmans, E. A. Physiological Botany. New York: D. Appleton & Co. Pp. 292. $1.40.

Alexander, E. Porter. Railway Practice. New York and London: G. P. Putnam's Sons. Pp. 60. 75 cents.

Newton, R. Heber. Social Studies. New York and London: G. P. Putnam's Sons. Pp. 380. $1.

Crane, Thomas F. Le Romantisme Français. New York and London: G. P. Putnam's Sons. Pp. 362. $1.50.

Russell, Israel C. Geological History of Lake

Lahontan. Washington: Government Printing-Office. Pp. 288.

Oliver, J. E., Walt, L. A., and Jones, G. W. Algebra. Ithaca, N. Y.: Dudley F. Finch. Pp. 412.

Jewett, Sarah Orne. The Normans. New York and London: G. P. Putnam's Sons. Pp. 373. $1.50.

Wilson, John. Thoughts on Science, Theology and Ethics. London: Trübner & Co. Pp. 197.

Hunt, T. Sterry. Mineral Physiology and Physiography. Boston: Cassino. Pp. 710.

Oswald, F. L. The Poison Problem. New York: D. Appleton & Co. Pp. 188. 75 cents.

Godoy, Adèle Josephine, translator. The Martyr of Golgotha. 2 vols. New York: William S. Gottsberger. Pp. 364. $1.50.

Cope, E. D. Origin of the Fittest. New York: D. Appleton & Co. Pp. 467. $3.

Warriner, E. A. I am that I am (poem). Boston: Cupples, Upham & Co. Pp. 167. $1.

Rodgers Locomotive Company. Locomotives and Locomotive-Building. New York: William S. Gottsberger. Pp. 198. $2.00.

POPULAR MISCELLANY.

The Origin of Languages.—Mr. Horatio Hale, in his address at the American Association, on "The Origin of Languages and the Antiquity of Speaking Man," reviewed the theories that have been offered on the former title of his subject, and declared them all unsatisfactory; for none of them can be made to account adequately and consistently for the number and diversities of the languages that prevail among men. And yet, he declares—and confirms his assertion with evidence that seems almost as clear as it is novel and interesting—that while some of the ablest reasoners have thus been groping vaguely and blindly, in wrong directions, for the solution of this problem, and while others have given it up in despair, "the simple and sufficient explanation has been lying close at hand, awaiting only, like many other discoveries in science, the observation of some facts of common occurrence to bring it to light." It is derived from two sets of observations, dating from nearly twenty years ago, which were published, one in 1868, and the other some ten years later, without attracting much attention. But they proved full of suggestion to the author, and led him to the conclusion, to which they seemed to point with irresistible force, "that the origin of linguistic stock is to be found in what may be termed the language-making instinct of very young children. From numerous cases, of which the history has been traced, it appears that, when two children, who are just beginning to speak, are left much together, they sometimes invent a complete language, sufficient for all purposes of mutual intercourse, and yet totally unintelligible to their parents and others about them." One of the observations was published by Miss E. H. Watson, of Boston, in 1878, and related to two children, twin-boys, in a suburb of Boston, who at the usual age, as she tells the story, "began to talk, but strange to say, not their 'mother-tongue.' They had a language of their own, and no pains could induce them to speak anything else. It was in vain that a little sister, five years older than they, tried to make them speak their *native language* as it would have been. They persistently refused to utter a syllable of English. Not even the usual first words, 'papa,' 'mamma,' 'father,' 'mother,' it is said, did they ever speak; and . . . they were never known during this interval to call their mother by that name. They had their own name for her, but never the English." While they had the usual affections for their parents, etc., they seemed to be otherwise completely taken up and absorbed with each other. "The children had not yet been to school; for, not being able to speak their 'own English,' it seemed impossible to send them from home. They thus passed the days, playing and talking together in their own speech, with all the liveliness and volubility of common children." They had regular words, and "even in that early stage, the language was complete and full; that is, it was all that was needed." Finally, there seeming to be no hope that they were going to learn "their own tongue," it was concluded, when they were six or seven years old, to send them to school. "For a week," as the lady teacher described, to whom they were sent, "they were perfectly mute; not a sound could be heard from them, but they sat with their eyes intently fixed upon the children, seeming to be watching their every motion—and, no doubt, listening to every sound. At the end of that time they were induced to utter some words, and gradually and naturally they began, for the first time, to learn their 'native English.' With this accomplishment, the other began, also naturally, to fade away, until the memory, with the use of it, passed from their minds."

Miss Watson did not become acquainted with these facts till it was too late to preserve a record of the language itself; but in the other case, a part of the language was preserved by a careful and scientific observer. This case occurred in Albany, New York, and was described, by Dr. E. R. Hun, in the "Monthly Journal of Psychological Medicine" in 1868. A little girl four and a half years old, the sprightly and intelligent child of cultivated parents, had been observed, when two years old, to be backward in speaking, "and only used the words 'papa' and 'mamma.' After that she began to use words of her own invention, and though she understood readily what was said, never employed the words used by others. Gradually she enlarged her vocabulary. . . . She has a brother eighteen months younger than herself, who has learned her language, so that they talk freely together. He, however, seems to have adopted it only because he has more intercourse with her than with others; and in some instances he will use a proper word with his mother, and his sister's word with her. She, however, persists in using only her own words, though her parents, who are uneasy about her peculiarity of speech, make great efforts to induce her to use proper words." Dr. Hun followed up this general description of the language with analyses of some of its words and other features. These two recorded instances of child-languages led Mr. Hale to further inquiries, which, though brief and limited, showed him that cases of the sort are by no means uncommon, and he cites a few other instances. In the light of the facts thus set forth, it becomes evident, says Mr. Hale, "that, to insure the creation of a speech which shall be the parent of a new linguistic stock, all that is needed is that two or more children should be placed by themselves in a condition where they will be entirely, or in a large degree, free from the presence and influence of their elders. They must, of course, continue in this condition long enough to grow up, to form a household, and to have descendants to whom they can communicate their new speech. We have only to inquire under what circumstances an occurrence of this nature can be expected to take place."

A Correction.—We find the following in "Science" of January 21st:

POPULAR SCIENCE.—It is often very popular indeed. Here is an article on the voices of animals by Detler von Geyern (whoever he is), from *Ueber Land und Meer*, translated for the *Popular Science Monthly*, January, 1887, written in the good old traditional vein, quoting what anybody has said on the subject in a wonder-mongering way, as if every thing said and written must be true. And Herr von Geyern himself says, "Fish can produce no sound in water, because air is lacking as a medium to propagate the waves of sound; and yet we incline to the belief that water itself may admit of forming some kind of sound-waves which the fish may be capable of exciting, and which will be experienced and comprehended by other fish;" and he adds, "As far as we are concerned, of course, fish will remain mute," etc.—as if between fifty and a hundred species of fish are not known to make sounds, many of which have been described and explained by naturalists; and as if water and every other elastic medium were not well known as propagators of sound, often better than air,—a fact familiar to boys, who hold their heads under water, while bathing, to hear the loud sound made by the striking-together of two stones under water in the hands of a companion at a little distance.

H. W. P.

Grinnell, Io., Jan. 14.

We very much regret that an error so obvious as the above should have escaped attention in the revision of the article in question; but we do not pretend to be infallible. The paper was accepted on its general merits as a bit of pleasant reading; and coming to us from an outside source, it could not receive that critical attention to every detail which our own translator is compelled, by the nature of the case, to give to each item of his work.

Self-Purification of Water.—F. Emich has carried out a series of experiments on the behavior of water when allowed to stand exposed to the air, and also when shaken up with air. He has further experimented with sterilized water, and on the behavior of waters submitted to the action of ozone and hydrogen peroxide. The self-purification of water, or the destruction of its organic and inorganic impurities, may be the consequence, either of a purely chemical process (oxidation), or of a biological process. It appears that, on exposure to or agitation with air, the

self-purification takes place only if the water has not been previously sterilized by boiling, and protected afterward against the entrance of germs. But if a sterilized water has been subsequently exposed to the air or mixed with ordinary water, it undergoes the same changes as waters that have not been sterilized; its oxidizable power and its ammonia decrease, while nitrous or nitric acid is formed. If, therefore, the development of organisms in the water is rendered impossible, self-purification is also impossible. Direct oxidation by atmospheric oxygen certainly does not take place; and, if ozone and hydrogen peroxide play a part, it is a subordinate one. The kind of living beings which effect the purification of waters will differ greatly according to circumstances. Such a change of species has actually been observed in one and the same water-course in the different stages of its pollution. Self-purification may take place, even when industrial refuse is allowed to flow into the water in addition to organic pollution. Dr. J. Soyka has made experiments on the power of the soil to absorb poisonous substances and destroy them; and has showed it to exist in the cases of strychnine and a considerable number of the organic alkaloids. His experiments have not been extended to the ptomaines. Nevertheless, we must beware of supposing that the treatment of foul waters can safely be left to Nature. Where the supply of polluting matter is continuous in time and space, natural purifying agencies fail. An important lesson to be learned from the researches of Emich and Soyka is, that the microbes, both of earth and water, are not all to be regarded as disease-generators. On the contrary, certain kinds of them are converting malignant matter into forms in which it is harmless, or even useful. Hence, it is at least possible that, in the application of disinfectants or "germicides," there is room for discretion.

School Life and Health.—Dr. Thomas Whiteside Hine, of Bradford, England, has made inquiries into the effect of school life upon the mortality of children, taking as the basis of his conclusions the reports of deaths among children of from five to fifteen years old, persons of that range of ages being regarded as probably those upon whom the effects of school life and work would be most marked. Comparing the returns from 1871 to 1880 with those from 1861 to 1870, he finds that while the mortality of children from all causes and from zymotic diseases — on which school influences are negative — has considerably diminished, their mortality from nervous diseases—the direction in which school influences would be most felt—has exceptionally remained stationary. To this he adds that the figures for 1881 and 1882 likewise show identical results in both instances. Further than this, he finds that there has been an improvement in the death-rate from nervous affections among children below five years, who are out of school, or have been in it for only a short time. Yet the whole of the mischief must not be attributed to the effect of schooling alone; but, as all the world lives faster than it did, the nervous system of children is likewise stimulated at the present day to an extent unknown a generation ago, and greatly to their disadvantage. The existence of such sources of mischief in the habits of the day supplies a strong reason why all school influences calculated to enhance the mischief should be removed.

Seasoning Timber.—Of the common sense of the question of seasoning timber, Mr. Thomas Blashill says, in an address on the general subject: "Wood must not be dried so quickly that it will be made unsound by cracks. It must not be dried so much that it will absorb fresh moisture when it comes into the atmosphere in which it has permanently to remain. It is not merely a question of time, but of judgment, the objects being to see that the timber is gradually reduced in scantling as it dries, and so treated in temperature and stacking that it neither splits nor gets out of shape. . . . To sum up the whole class of questions connected with seasoning, we want timber that will not shrink after it is brought into use, that will not work or twist out of shape, will not decay through damp, and will not be destroyed by insects. Wood may also be indurated, that being the result of polishing and of varnishing to some extent. Upon the whole, it is desirable to encourage all means of treating wood so that it may possess some

of the advantages that are commonly attributed to iron and stone. In cutting up timber for use, the question of its grain as developed by the annual rings is of very great importance. The shrinkage being greater in the newer layers of wood, it must be cut so that this irregular shrinkage may be of no disadvantage." In oak, in order to show the beauty of the grain, as well as to provide wainscot-boards that will be true in shape, it is necessary to get the boards as far as possible to radiate from the center to the outside of the log. If this is done, the medullary rays are cut through in many places, so as to show the silver grain. Ash-timber does not appear to have any sap-wood, all the wood being of the same color; and there are foreign woods with the same peculiarity. But the worm finds out the part that is sap-wood. In elm-timber the sap is reckoned as good as the heart. The timber does not improve by seasoning, but should be used green, and even kept wet until wanted for use. When used in flooring, the oldest elm boards have been known to shrink considerably, if they were merely taken up and planed.

Stanley Jevons on Mathematics and Meteorology.—Professor Jevons wrote to his sister, June 17, 1857: "I have never had the courage to open the many mathematical books I brought with me; but what do you think I would do if I had opportunity ever again? Attend college and De Morgan's mathematical lectures! The utility of mathematics is one of the most incomprehensible things about it; but though I was never bright or successful in his class, in spite of working hard, I feel the greatest benefit from it. Mathematics are like the calisthenic exercises of the mind, and make it vigorous and correct in form and action; but it depends, of course, on other circumstances how you apply and use your mind as well as your body. To go figuring about with your arms or legs is not the object of calisthenics. I think, therefore, you can not waste time or trouble spent over mathematics—the more the better, for the present at all events. . . . I do not mean you to enter on the study of meteorology, for it is a most troublesome, extensive, and to most an uninteresting subject. I have, however, involved myself in it to an awful extent, and must go on with it, I suppose, while I am here [in Australia, engaged in the Mint at Sydney, and furnishing weekly reports to the 'Empire']. It is a most complicated subject, requiring a knowledge more or less of heat, light, chemistry, electricity, etc.; and is, therefore, a sort of difficult scientific exercise rather than a science itself."

A Legend of Monkeys and Stones.—Prince Carl, of Sweden and Norway, when starting out from Hyderabad, India, on a tiger-hunt in 1883, was struck by the scenery around the city, where the undulating ground is strewed with huge blocks of stone, "as if they had been tossed hither and thither by Nature in some capricious mood. Some of the blocks are piled upon each other in such a manner as to cause a lively imagination to fancy them giants and trolls barring the way. According to Indian folk-lore, these blocks were brought hither, some four thousand years ago, in this manner: The monkeys, which in the earliest of times in great numbers inhabited the lands beyond the Himalayas, seized on the remarkable idea of building a bridge between the mainland and Ceylon, and, headed by their leaders, they left their settlements in great numbers for the south, carrying with them from their mountains materials for their gigantic bridge. But the road became too long for them, and they were obliged, on reaching the spot where Hyderabad now stands, to throw their loads away, and here they lie to-day."

Jade Ornaments in America.—At a recent meeting of the American Antiquarian Society, Mr. Frederick W. Putnam exhibited a collection of celts, axes, and ornaments made of various stones known under the general term of jade. They were from various places; and among them were one with a cutting edge at each end, and twelve specimens from Nicaragua and Costa Rica. Of the twelve, ten were ornaments which had been made by cutting celts into halves, quarters, or thirds, and on each of which a part of the cutting edge of the celt remained. One of the ornaments had been compared by Professor Cooke with a cup of jadeite from China, and found to be like it in color, hardness, and specific gravity. The mineral

jade, or jadeite—which varies in color from almost milk-white, with a slight shade of green, to a beautiful emerald-green—has not been found in place in America. So far as is known, all the varieties come from Asia. That it was rare, and regarded of great value among these Central American people, is shown by the fact that they wrought it into finished ornaments with such care, and that to make those ornaments they cut up celts already of value as useful manufactured articles, instead of using rough stones. The question is then in place, whether it is not reasonable to believe that the stone was brought from Asia in the form of implements by the early migrants to this country; and that, as the supply was not kept up, and most likely even its source became unknown, the pieces among the people were cut and recut, and preserved as sacred relics of the past, to be, one after the other, finally buried with their owners?

Oscillations of Italian Soil.—M. Quesnault read a paper, at the recent meeting of the French Association, on his researches into the oscillations of the ground and the movements of the sea. He had already laid some of his observations on the subject before the previons meeting of the Association, and they had been received with favor. He ascribed the changes of level which the ground undergoes to two very different causes: those of one character, sudden and transitory, were traceable to volcanic phenomena; others were attributable to sublunary and atmospheric influences. Those more general movements, which manifest themselves slowly and regularly either in depression or elevation, could be explained only on the supposition of an astronomical revolution of long duration not yet ascertained, that modifies the center of gravity of our planet and the motion of the waters that cover it. Professor Issel, of the University of Genoa, presented some valuable facts on the modifications of level, both slow and rapid, which the soil of Italy has undergone through a long series of years. Some of these facts, the result of slow and secular movements, are well worthy of attention. Thus, the Venetian estuary and Istria have been subject during historical times to a sensible depression which amounts at Venice to three or four centimetres in a century. The same movement is very evidently manifested on the coasts of Dalmatia, Albania, and Greece, and probably extends across the Mediterranean to Barbary and Egypt. Malta is or has been in the track of the depression. In Sicily, less evidently, Professor Issel takes notice of an elevation, which may have amounted to between four and six metres, since 400 B.C. A similar movement seems to have taken place on the Calabrian littoral opposite to Sicily; but this fact of elevation being common to nearly the whole of the Mediterranean basin, we are led to connect it with some astronomical phenomenon rather than with a change in the level of the sea. Professor Issel also remarks that, while we observe signs of recent depression at certain points of the Italian coasts, other evidences are plainly exhibited of a previous elevation (quaternary), which attained, in Liguria, a height of twenty metres.

Barometric Wells.—Some wells in Meyrin, Canton of Geneva, Switzerland, have barometric properties. They have been closed at the top, except for a small air-hole, and through this the wind blows in or out, according to the conditions of atmospheric pressure, sometimes with force enough to make a sound like that of a steam-whistle. If a hat or any light article be put over the hole when the barometer is falling, it will be blown up at once; but if the outer pressure is rising, the draught will bring leaves and other light objects toward the well. The people of the village understand the action of the wells, and make it their weather-gauge. The origin of the phenomenon is easily explained. It is dependent upon the differences that may be produced at any time between the pressure of the air within the wells and that of the outer atmosphere.

Asafœtida.—The gum asafœtida is derived from an umbelliferous plant (*Ferula asafœtida*) which grows in Persia and Afghanistan and other parts of Central Asia. Some information regarding the preparation of the gum is given in Dr. Jaworsky's account of his travels in those regions, which was published during 1885. The author

was given a whole plant, with root and stem, by a native, and found its odor penetrating enough. The stem is three or four feet high; the leaves are incised like those of other umbelliferous plants. The root is impregnated with the gum, which exudes wherever a cut is made, appearing of a light amber-color, hard consistency, and somewhat crystalline look. The root bears numerous side-roots, and is covered with a brown, scaly skin, crossed with rings. The plant grows in stony ground, blooms in the spring-time, and is propagated from the seeds. The gum is not collected from the roots till the plant is fifteen years old. At that time the stalk is cut off after the plant has blossomed and the seed has ripened. In a day or two afterward there exudes a thick, creamy, whitish juice, that soon becomes brown and hard. In about twelve days the amber-colored gum is taken off. A new cut is then made in the plant, and another "crop" of gum collected; and the operation may be repeated, if the season is favorable, six or eight times in a single summer. But the returns from the later cuttings are inferior to those from the first. A single root may furnish from a half pound to a pound of the gum in a season. Rain spoils the gum, and if it happens to be wet during the time of collecting, the crop for that year will have to be written down a failure. The plant that has been once operated upon is left to itself for ten or twelve years, when it becomes available for another crop.

Brain-Volume and Intelligence.—Dr. Adolph Bloch has published in the "Revue d'Anthropologie" a memoir on the relations existing between intelligence and the volume of the brain in man. He concludes that there is no absolute relation, for very intelligent persons may have a small brain, and individuals of very mediocre capacity a large one. We may also find among some races which are not considered very intelligent a brain or cranial capacity of relatively considerable amplitude. The conditions, moreover, which make the brain to be larger or smaller are manifold. The volume of the encephalus may be related to the size, to the weight of the body, and to the muscular power; and the brain itself may become voluminous in the race and the individual according to the degree of intellectual activity. The most important factor in the degree of the intelligence of the individual is the quality of the cerebral cell; and that is determined by the greater or less impressionability or excitability of that structure regarded as the substratum of intelligence. This impressionability may be native or acquired. In the former case it is the mark of a superior intelligence; in the latter, it may be produced by such sustained labor as every man of genius is compelled to endure. It may also be developed by nervous disease. In a whole race, there are influences, not depending on the individual, but acting upon all that contribute to the perfection of intelligence and the selection of remarkable men. The kind and degree of intelligence are also variable according to races; but in no case can the volume of the brain alone constitute the principal factor of intelligence.

The Protection of Rare Species of Plants.—The Association for the Protection of Plants, at Geneva, Switzerland, Henry Correvon secretary, has issued a circular, setting forth its objects and inviting horticulturists and collectors to assist it in carrying them out. The circular alludes to the anxiety which naturalists feel lest some rare species may be extinguished through the operations of man; and others which but for the possession of unusual means of defense would be in danger of succumbing at once under an attack of more than ordinary vigor. Some species are approaching the term of their existence. Their end may be hastened by man, although he may perhaps not be able greatly to prolong their lives. Some plants are cultivated in modified forms as choice varieties, while the original stocks are neglected and allowed to die out; some, of foreign origin, live a kind of colonial existence in particular countries, and need care to preserve them there. Some are the objects of vigorous search by amateurs and horticulturists, who often pluck them recklessly without reflecting that the place where they are found may be the only spot in the country where they occur. The *Dracocephalum Austriacum* and *Dictamus frazinella* have nearly disappeared from their native haunts. Plants like the *Paradisia lilia-*

strum, the *Anemone sulfurea* and the *Ranunculus glacialis* are taken from the Alps by ten thousand at a time; and a lot of four thousand edelweiss was recently shipped to America. If the plants are not taken up with proper care, eighty out of a hundred of them will probably perish, and fifty more will be trampled upon or mutilated in getting the hundred. The Swiss Association does not object to the collecting of the plants; it only wants them collected in such a manner that no danger shall be incurred of destroying or diminishing the species. It seeks to point out how this may be done, by selecting the season when removal will involve no danger to the life and vigor of the plant, and especially by insisting upon a more general adoption of cultivation and reproduction by seed. It has established a garden of acclimatation near Geneva, where the seeds of mountain-plants are raised to be sold at a moderate price, from which it has already obtained good results; for many persons who used to plunder the mountains now go to it for seeds. It does not confine its attention to the plants of its own country, but keeps a good lookout also for the well-being of rare species in other lands; and has agents in Mexico and Brazil to intercede with the authorities for the institution of measures to secure the preservation of the cactuses of the former country and the orchids of the latter.

Glacial Action in East Africa.—Mr. H. E. O'Neill, British consul at Mozambique, in a description of Eastern Africa, between the Zambesi and Rovuma Rivers, speaks of the frequency with which one encounters evidence of glacial action as a very interesting point to the traveler in that country. "I have met with it," he says, "upon the Namuli range, in the Inagu Hills, and again much nearer the coast, among a small block of hills called the Tugni. You see it everywhere in the smooth, dome-shaped tops and polished precipitous sides of the hills of the country, but the clearest evidence is afforded by the more striking spectacle of huge detached blocks lying across the summits of peaks—blocks many tons in weight, which could never have been carried there by any other known physical agency than that of ice."

Our Oldest Herbaria.—President William Carruthers, in the Biological Section of the British Association, spoke of the value of herbaria, or collections of dried specimens of plants, for supplying the most certain materials for the minute comparison at any future time of the then existing vegetation with that of our own day. We have now collections in England about two hundred years old that have been used for that purpose. Dr. Schweinfurth has obtained specimens, which were originally deposited in the form of offerings, from Egyptian tombs, four thousand years old, which are as satisfactory for the purposes of science as any collected at the present day, and which consequently supply means for the closest examination and comparison with their living representatives. The colors of the flowers are still present, even the most evanescent. The chlorophyl remains in the leaves, and the sugar in the pulp of the raisins. Dr. Schweinfurth has determined fifty-nine species, some of which are represented by fruits, others by flowers and leaves, and the remainder by branches. Mr. Carruthers also referred to the deposits discovered at Cromer, and the remains which exist of pre-glacial flora, and came to the conclusion that the various physical conditions that necessarily affected those species in their diffusion over such large areas of the earth's surface in the course of, say, two hundred and fifty thousand years, should have led to the production of many varieties, but the uniform testimony of the remains of this pre-glacial flora, so far as the materials admit of a comparison, is that no appreciable change has taken place.

Coal-Mine Gas-Explosions and the Weather.—Mr. H. Harries remarks, in "Iron," that though a connection is believed to exist between fire-damp in coal-mines and atmospheric changes, its nature is not well understood. The rule is probably analogous to that which controls weather-changes, which are not indicated by definite points in the barometric scale, but by differences in pressure between neighboring places. He thinks, therefore, that it is desirable to ascertain whether the presence of gas in mines is, like the weather, distributed in areas, and whether

er within those areas some localities would have more gas than others, according to the inequalities in the distribution of pressure. Mr. Harries invites officers in coal-mines to supply him with observations of the pressure of gas in their mines, taken once a day, in the morning—at least for the four months ending with December 31st. The information thus supplied will be compared with that furnished by the weather-charts for the same hours.

Disappearance of an Island.—According to the official newspaper of the Faroe Islands, the rock-island of Munken, south of Sumbö, which was one of the most prominent landmarks of the group, has sunk. It had stood seventy feet above the level of the sea, but several months ago a large proportion of the rock had crumbled away, so that the tide washed over most of its surface. The shallow waters around the island formed dangerous currents, with eddies, or maelstroms, which were much dreaded by mariners. Pastor Lucas Jacobsön Debes, in 1673, gave a graphic description of the maelstrom, with the Sumbö Munken rock rising from amid it, and asserted that the compass lost its polarity there. Pastor Jürgen Landt, in 1800, also wrote about the maelstrom, and described the island as presenting, when seen from the water, the appearance of a ship under full sail; and from the land, the likeness of a monk, having a neck of red clay, and a head and body of a dark-gray stone, or coarse basalt. On the 28th of May, 1885, the Danish Minister of the Marine reported that Munken had fallen in, and so one of the most striking objects in the Faroe group, which had been sailed past and admired by thousands of sailors, and played an important part in geographical literature, had disappeared.

Laterite and its Odors.—A writer in "Das Ausland" states that in a certain district of West Africa the soil is largely composed of an argillaceous deposit called laterite, which is very porous and freely penetrable by water to its lowest depth. As the water penetrates it, the air contained in it is of course driven out. This air being charged with decomposing organic matters washed in by the rain, the emanations after a strong shower are decidedly malodorous. As violent storms are not unfrequent, they are regular and strong enough to attract the attention of the natives, and they give them a name which may be translated meadow-stink.

NOTES.

THE steel-plate portrait of the late editor of this magazine, published in the present number, is by Mr. Charles Schlect, and is considered by the friends of Professor Youmans a spirited and excellent likeness.

MR. W. STAINTON MOSES, lately a vice-president, has withdrawn from the English Society for Psychical Research, on the ground that the evidence for phenomena of the genuine character of which he and others have satisfied themselves beyond a doubt, is not properly entertained or fairly treated by it.

PROFESSOR BURT G. WILDER looks forward to a time when the terms used in anatomy will be simplified and made to agree with a uniform standard. Replying to criticism of the modifications he has himself introduced in such terms, he claims to have endeavored to hasten what seemed to be the natural progress of reform. Very few terms used by him do not occur in the writings of some anatomist of authority. He has selected what seemed to him the best, modified them, when desirable, in accordance with established etymological rules, and has "always used the same word for the same thing." This he has done consistently and persistently; and whatever new terms he puts forth are first tested in the laboratory and lecture-room.

THERE is no doubt, the "Lancet" believes, that woman can, if she will, qualify herself to do anything that a man can do; for "no physiologist will question the possibility of developing by appropriate stimuli, exercise, and food, any particular part or parts of an organism in such a manner as to make it respond to the demands of its environment"; and it must therefore be theoretically possible that the woman shall be developed in respect to any one or more of her organic potentialities to a level with the male. But she must do so at the expense of some other power, and this is usually at the sacrifice of some function that makes her valuable as a woman. The real question in the matter is, whether it is worth while to pay so great a price for the privilege.

FOURTEEN European scholars in China recently had a discussion of the question whether Western knowledge, and particularly science, should be conveyed to the Chinese through the medium of their own

or of a Western language. The general tendency of their views, which varied as to details, was in favor of exciting the curiosity and interest of intelligent Chinese in the matter of Western knowledge by popular expositions in the native tongue, reserving a more adequate representation for a time when a sufficient number of Chinese shall have acquired foreign languages to constitute a learned class in our sense of the expression. A further and final stage will be reached when the members of this class shall become the conveyers of knowledge to their countrymen in a vernacular improved and adapted to the comprehension of scientific ideas.

MR. J. W. WALKER has discovered a site on Pine Mountain, Georgia, where the ancient inhabitants of the region manufactured their talc vessels for cooking, with indubitable evidences of the use of stone implements in the work. Other similar sites have been found in the District of Columbia, and in Southern California.

SOME doubt is thrown upon the "cavern theory" of the origin of minor earthquakes by the publication of Professor O'Reilly's catalogue of British earthquakes and its accompanying map. The data show that, during the period embraced in the view, Ireland has been less subject to earthquakes than England and Wales. In the face of this revelation is the fact that Ireland is remarkably and excessively undermined by cavernous formations, so that if they really give rise to earthquake-shocks, it should have suffered more from them than any other country represented.

A LARGE group of mineral springs in the Transbaikal region of Russia have gained a high repute for their curative effects on men and animals. Their temperature ranges from 35° to more than 100° Fahr. Some are ferruginous, some alkaline, and others sulphurous in composition.

THE slopes and environs of the volcanic mountains Etna and Vesuvius are and always have been famous for their fertility, by which large populations are tempted to live, where they are in constant danger of being destroyed by an eruption. The richness of the soil has been traced to fertilization by volcanic ashes, which have been determined to be remarkably rich in their phosphoric acid and potash constituents. Accounts from the district in New Zealand that was flooded with ashes by last June's eruption indicate likewise that the disaster there is likely to prove a "blessing in disguise."

GOLD in quantities worthy of attention has been found in the neighborhood of St. Sebastian Bay, Terra del Fuego. It exists in little flakes and oval grains.

PROFESSOR W. MATTIEU WILLIAMS observes that political economists condemn the precept of the Sermon on the Mount, which bids us take no heed of to-morrow, and acknowledges that it is in opposition to the established laws of our political economy. But, he asks, is our political economy a universal science, or is it only the economics of the temperate zone? The primary reason for the duty of thrift that is imposed on us is that in our latitude the earth only yields its fruits during a part of the year, and we have therefore to make stores of food and other material produced by annual harvests. In tropical countries, and to a certain extent in such sub-tropical regions as Palestine, there is little or no necessity to gather into barns, as it is there quite possible to have a daily harvest by arranging a suitable succession of crops.

A WOMAN'S journal—called "La Rassegna degli interessi femminili," or "Review of Feminine Interests"—has been started, under the direction of Fanny Zampini Salazaro. It will be adapted to Italian women of all ranks and stations in life, and, while it will not neglect the lighter matters, it proposes to give prominence to those things that are solid and will contribute to the economical well-being and mental development of its constituency. It will consider what relates to women's duties, work, and recreation, and the fields of activity that may be open to them. Domestic duties and the care and training of children will also have a place in it. "La Rassegna" will be published on the 15th of every month, in octavo form. The first number is before us. It is filled with matter of solid interest, and presents a very creditable appearance.

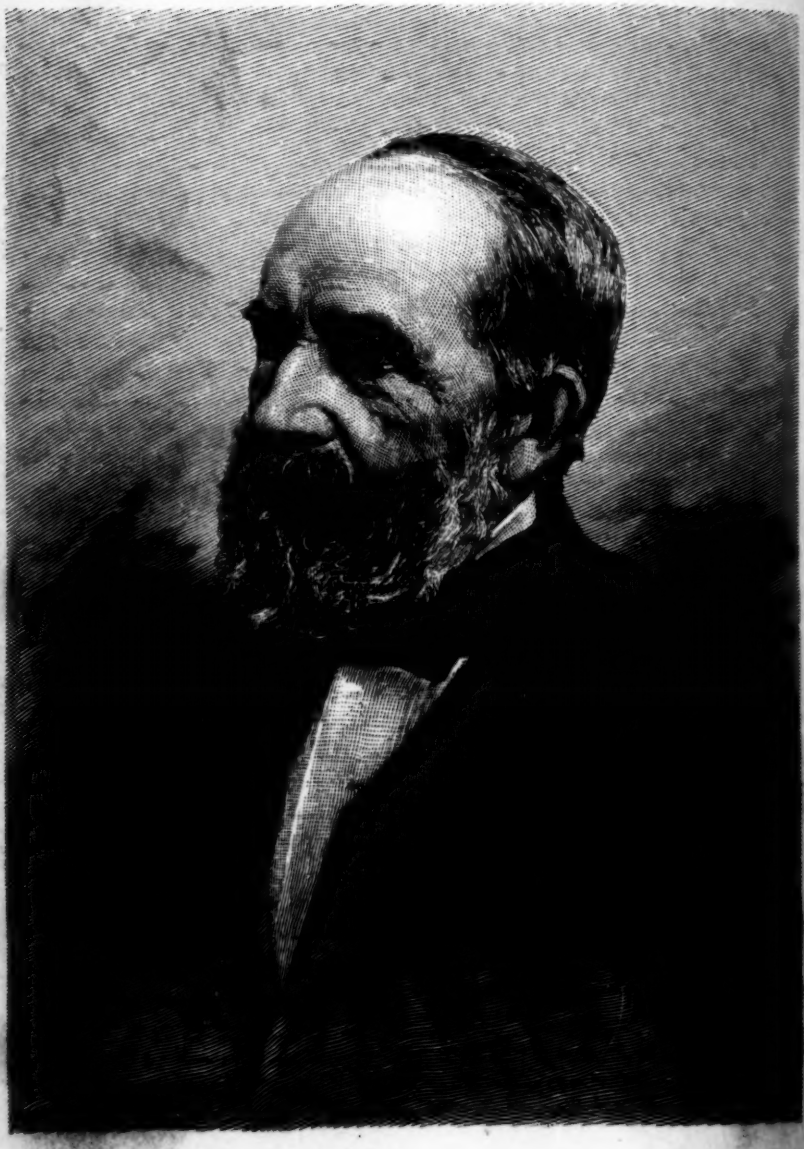
OBITUARY NOTES.

MR. JULES LICHTENSTEIN, whose name is associated with researches with regard to the phylloxera, is dead.

THE death of Professor M. Websky, one of the most distinguished mineralogists in Germany, is reported.

MRS. THOMAS SAY, widow of the eminent naturalist, died at Lexington, Massachusetts, November 15th.

MR. ARTHUR GROTE, author of many papers on subjects of natural history, died in London, December 4th. He was a brother of George Grote, author of the "History of Greece," and was born in 1814. He spent thirty-four years in the civil service in Bengal, where he was President of the Royal Agricultural Society of India, and of the Asiatic Society of Bengal. Returning to England in 1868, he became a prominent member of the Linnæan and Royal Asiatic Societies.



LEO LESQUEREUX.